MINER'S ALMANAC
1864

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CALIFORNIA
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INV. 1898.

THE CALIFORNIA

MINER'S ALMANAC

FOR

1864,

CONTAINING

EXTRACTS FROM MODERN FRENCH, GERMAN AND ENGLISH WRITERS

ON

METALLURGY, GEOLOGY, MINERALOGY, MINING AND ASSAYING;

USEFUL DIRECTIONS FOR PROSPECTING FOR GOLD, SILVER OR COPPER;

METHODS OF RECOGNIZING AND ASCERTAINING THE NATURE OF ORES;

MEXICAN MINES,

ABRIDGMENT OF MEXICAN LAWS ON MINING;

STAMP DUTIES, ETC., ETC.

SAN FRANCISCO:
HENRY PAYOT, BOOKSELLER & PUBLISHER,
No. 640 Washington Street.

L. Albin, Printer, No. 622 Clay Street.

Eclipses in 1864.

In the year 1864 there will be two Eclipses, both of the Sun:

I. An Eclipse of the Sun visible at San Francisco.

		h.	m.	
Begins	May 5th.....	4	28	P. M.
Middle	„ „	5	38	„
Ends	„ „	6	49	„

Size 9 digits.

II. An annular Eclipse of the Sun, October 30th; invisible.

Moveable Feasts.

Epiphany.....	Jan. 6	Easter Sunday.....	Mar. 27
Septuagesima Sunday...	" 24	Ascension Day.....	May 5
Ash Wednesday.....	Feb. 10	Pentecost.....	" 15
St. Patrick.....	Mar. 17	Michaelmas Day.....	Sep. 29
Palm Sunday.....	" 20	First Sunday in Advent.	Nov. 27
Good Friday.....	" 25	Christmas Day.....	Dec. 25

Equinoxes and Solstices.

			h.	m.	
Vernal Equinox.....	March	22d.....	6	17	A. M.
Summer Solstice.....	June	21st.....	11	43	P. M.
Autumnal Equinox.....	Sept.	21st.....	5	43	A. M.
Winter Solstice.....	Dec.	21st.....	11	43	A. M.

Chronological Cycles.

Golden Number.....	3	Dominical Letters.....	C B
Epact.....	22	Roman Indiction.....	7
Solar Cycle.....	25	Julian Period.....	6577

Morning and Evening Stars.

VENUS will be Morning Star until July 12th, then Evening Star the rest of the year.

MARS will be Morning Star until November 28th, then Evening Star the rest of the year.

JUPITER will be Morning Star until May 12th, then Evening Star until November 26th, then Morning Star the rest of the year.

SATURN will be Morning Star until April 5th, then Evening Star until October 10th, then Morning Star the rest of the year.

ALMANAC FOR 1864.

JANUARY.

MOON'S PHASES.

Last Quarter, 1d. 11h. 29 m. A.
New Moon, 8d. 11 h. 35 m. A.
First Quarter, 15d. 2h. 56m. A.
Full Moon, 23d. 1h. 52m. A.
Last Quarter, 31d. 4h. 7m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Friday	7 21	4 46	morn
2	Saturd'y	7 21	4 47	0 26
3	SUND'Y	7 21	4 48	1 26
4	Monday	7 21	4 49	2 29
5	Tuesday	7 21	4 50	3 33
6	Wednes	7 21	4 51	4 39
7	Thursd'y	7 21	4 52	5 42
8	Friday	7 21	4 53	sets
9	Saturd'y	7 21	4 53	5 39
10	SUND'Y	7 21	4 54	6 51
11	Monday	7 21	4 55	8 03
12	Tuesday	7 20	4 56	9 12
13	Wednes	7 20	4 58	10 21
14	Thursd'y	7 20	4 59	11 28
15	Friday	7 20	5 00	morn
16	Saturd'y	7 19	5 01	0 33
17	SUND'Y	7 19	5 02	1 36
18	Monday	7 19	5 03	2 36
19	Tuesday	7 18	5 04	3 33
20	Wednes	7 18	5 05	4 26
21	Thursd'y	7 17	5 06	5 14
22	Friday	7 17	5 07	5 59
23	Saturd'y	7 16	5 08	Rises
24	SUND'Y	7 16	5 09	6 35
25	Monday	7 15	5 10	7 30
26	Tuesday	7 15	5 11	8 25
27	Wednes	7 14	5 12	9 20
28	Thursd'y	7 13	5 14	10 18
29	Friday	7 12	5 15	11 16
30	Saturd'y	7 11	5 16	morn
31	SUND'Y	7 10	5 17	0 15

FEBRUARY.

MOON'S PHASES.

New Moon, 7d. 10h. 0m. M.
First Quarter, 14d. 5h. 14m. M.
Full Moon, 22d. 8h. 51m. M.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Monday	7 09	5 19	1 17
2	Tuesday	7 08	5 20	2 20
3	Wednes	7 07	5 21	3 22
4	Thursd'y	7 06	5 22	4 21
5	Friday	7 05	5 23	5 16
6	Saturd'y	7 04	5 24	6 07
7	SUND'Y	7 03	5 25	sets
8	Monday	7 02	5 26	6 48
9	Tuesday	7 01	5 27	8 00
10	Wednes	7 00	5 28	9 11
11	Thursd'y	6 59	5 29	10 17
12	Friday	6 58	5 31	11 24
13	Saturd'y	6 57	5 32	morn
14	SUND'Y	6 55	5 33	0 26
15	Monday	6 54	5 34	1 26
16	Tuesday	6 53	5 35	2 22
17	Wednes	6 52	5 36	3 11
18	Thursd'y	6 51	5 37	3 58
19	Friday	6 50	5 38	4 37
20	Saturd'y	6 49	5 39	5 14
21	SUND'Y	6 47	5 40	5 47
22	Monday	6 46	5 41	rises
23	Tuesday	6 45	5 42	7 15
24	Wednes	6 43	5 43	8 13
25	Thursd'y	6 42	5 44	9 09
26	Friday	6 41	5 45	10 08
27	Saturd'y	6 39	5 47	11 09
28	SUND'Y	6 38	5 48	morn
29	Monday	6 37	5 49	0 09
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ALMANAC FOR 1864.

MARCH.

MOON'S PHASES.

Last Quarter, 1d. 5h. 2m. M.
New Moon, 7d. 7h. 49m. A.
First Quarter, 14d. 9h. 57m. A.
Full Moon, 23d. 2h. 14m. M.
Last Quarter, 30d. 2h. 10m. A

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Tuesday	6 36	5 50	1 10
2	Wednes	6 35	5 51	2 08
3	Thursd'y	6 33	5 51	3 04
4	Friday	6 32	5 52	3 53
5	Saturd'y	6 30	5 53	4 39
6	SUND'Y	6 29	5 54	5 20
7	Monday	6 28	5 55	6 00
8	Tuesday	6 26	5 56	sets
9	Wednes	6 25	5 57	7 55
10	Thursd'y	6 23	5 58	9 04
11	Friday	6 21	5 59	10 10
12	Saturd'y	6 20	6 00	11 13
13	SUND'Y	6 18	6 01	morn
14	Monday	6 17	6 02	0 12
15	Tuesday	6 15	6 03	1 06
16	Wednes	6 14	6 04	1 53
17	Thursd'y	6 12	6 05	2 35
18	Friday	6 10	6 06	3 14
19	Saturd'y	6 09	6 07	3 49
20	SUND'Y	6 07	6 08	4 19
21	Monday	6 06	6 09	4 49
22	Tuesday	6 04	6 10	5 18
23	Wednes	6 03	6 11	rises
24	Thursd'y	6 01	6 11	8 01
25	Friday	6 00	6 12	9 03
26	Saturd'y	5 58	6 13	10 04
27	SUND'Y	5 57	6 14	11 03
28	Monday	5 55	6 15	morn
29	Tuesday	5 54	6 16	0 02
30	Wednes	5 52	6 17	0 57
31	Thursd'y	5 50	6 18	1 47

APRIL.

MOON'S PHASES.

New Moon, 6d. 5h. 39m. M.
First Quarter, 13d. 3h. 58m. A.
Full Moon, 21d. 5h. 9m. A.
Last Quarter, 28d. 8h. 24m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Friday	5 49	6 19	2 32
2	Saturd'y	5 47	6 20	3 24
3	SUND'Y	5 46	6 21	3 53
4	Monday	5 44	6 22	4 29
5	Tuesday	5 43	6 23	5 06
6	Wednes	5 42	6 23	sets
7	Thursd'y	5 40	6 24	7 49
8	Friday	5 39	6 25	8 54
9	Saturd'y	5 37	6 26	9 56
10	SUND'Y	5 35	6 27	10 54
11	Monday	5 34	6 28	11 46
12	Tuesday	5 32	6 29	morn
13	Wednes	5 31	6 30	0 30
14	Thursd'y	5 29	6 31	1 10
15	Friday	5 28	6 32	1 47
16	Saturd'y	5 26	6 33	2 19
17	SUND'Y	5 25	6 33	2 50
18	Monday	5 24	6 34	3 18
19	Tuesday	5 23	6 35	3 48
20	Wednes	5 21	6 36	4 19
21	Thursd'y	5 20	6 37	rises
22	Friday	5 19	6 38	7 56
23	Saturd'y	5 18	6 39	8 56
24	SUND'Y	5 16	6 40	9 56
25	Monday	5 15	6 41	10 53
26	Tuesday	5 14	6 41	11 43
27	Wednes	5 12	6 42	morn
28	Thursd'y	5 11	6 43	0 31
29	Friday	5 10	6 44	1 13
30	Saturd'y	5 09	6 45	1 51
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ALMANAC FOR 1864.

MAY.

MOON'S PHASES.

New Moon, 5d. 4h. 4m. A.
First Quart., 13d. 10h. 10m. M.
Full Moon, 21d. 5h. 14 m. M.
Last Quarter, 28d. 1h. 11m. M.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	SUND'Y	5 08	6 46	2 27
2	Monday	5 07	6 46	3 03
3	Tuesday	5 06	6 47	3 40
4	Wednes	5 05	6 48	4 17
5	Thursd'y	5 04	6 49	4 57
6	Friday	5 03	6 50	sets
7	Saturd'y	5 02	6 50	8 40
8	SUND'Y	5 01	6 51	9 34
9	Monday	5 00	6 52	10 23
10	Tuesday	4 59	6 53	11 09
11	Wednes	4 58	6 54	11 44
12	Thursd'y	4 57	6 55	morn
13	Friday	4 56	6 56	0 19
14	Saturd'y	4 55	6 57	0 53
15	SUND'Y	4 54	6 57	1 19
16	Monday	4 53	6 58	1 48
17	Tuesday	4 52	6 59	2 18
18	Wednes	4 51	7 00	2 49
19	Thursd'y	4 50	7 01	3 23
20	Friday	4 50	7 01	4 01
21	Saturd'y	4 49	7 02	rises
22	SUND'Y	4 49	7 03	8 45
23	Monday	4 48	7 0-	9 39
24	Tuesday	4 48	7 04	10 29
25	Wednes	4 47	7 05	11 13
26	Thursd'y	4 47	7 06	11 53
27	Friday	4 46	7 07	morn
28	Saturd'y	4 46	7 08	0 29
29	SUND'Y	4 45	7 08	1 04
30	Monday	4 45	7 09	1 39
31	Tuesday	4 44	7 10	2 15

JUNE.

MOON'S PHASES.

New Moon, 14d. 3h. 30m. M.
First Quart., 12d. 3h. 38m. M.
Full Moon, 19d. 2h. 44m. A.
Last Quarter, 26d. 6h. 5m. M.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Wednes	4 44	7 11	2 53
2	Thursd'y	4 44	7 11	3 36
3	Friday	4 43	7 12	4 21
4	Saturd'y	4 43	7 13	sets
5	SUND'Y	4 43	7 13	8 15
6	Monday	4 43	7 14	9 01
7	Tuesday	4 43	7 15	9 41
8	Wednes	4 43	7 16	10 18
9	Thursd'y	4 42	7 16	10 50
10	Friday	4 42	7 16	11 20
11	Saturd'y	4 42	7 17	11 48
12	SUND'Y	4 42	7 17	morn
13	Monday	4 42	7 17	0 18
14	Tuesday	4 42	7 18	0 48
15	Wednes	4 42	7 18	1 20
16	Thursd'y	4 42	7 19	1 57
17	Friday	4 42	7 19	2 37
18	Saturd'y	4 42	7 19	3 25
19	SUND'Y	4 42	7 20	rises
20	Monday	4 43	7 20	8 22
21	Tuesday	4 43	7 20	9 10
22	Wednes	4 43	7 20	9 52
23	Thursd'y	4 43	7 21	10 30
24	Friday	4 44	7 21	11 07
25	Saturd'y	4 44	7 21	11 43
26	SUND'Y	4 44	7 21	morn
27	Monday	4 45	7 21	0 17
28	Tuesday	4 45	7 21	0 54
29	Wednes	4 45	7 21	1 34
30	Thursd'y	4 46	7 21	2 17

ALMANAC FOR 1864.

JULY.

MOON'S PHASES.

New Moon, 3d. 4h. 14m. A.
First Quarter, 11d. 7h. 41m. A.
Full Moon, 18d. 10h. 26m. A.
Last Quarter, 25d. 0h. 36m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Friday	4 46	7 21	3 05
2	Saturd'y	4 47	7 21	3 56
3	SUND'Y	4 47	7 21	4 50
4	Monday	4 48	7 20	sets
5	Tuesd'y	4 48	7 20	8 17
6	Wednes	4 49	7 20	8 51
7	Thursd'y	4 49	7 20	9 22
8	Friday	4 50	7 19	9 51
9	Saturd'y	4 51	7 19	10 22
10	SUND'Y	4 51	7 19	10 48
11	Monday	4 52	7 18	11 20
12	Tuesday	4 53	7 18	11 54
13	Wednes	4 53	7 18	morn
14	Thursd'y	4 54	7 17	0 30
15	Friday	4 55	7 17	1 13
16	Saturd'y	4 55	7 17	2 01
17	SUND'Y	4 56	7 16	2 59
18	Monday	4 57	7 16	rises
19	Tuesday	4 57	7 15	7 46
20	Wednes	4 58	7 15	8 27
21	Thursd'y	4 59	7 14	9 09
22	Friday	4 59	7 13	9 43
23	Saturd'y	5 00	7 12	10 18
24	SUND'Y	5 01	7 11	10 56
25	Monday	5 02	7 10	11 35
26	Tuesday	5 03	7 06	morn
27	Wednes	5 03	7 07	0 18
28	Thursd'y	5 04	7 08	1 03
29	Friday	5 05	7 07	1 52
30	Saturd'y	5 05	7 06	2 44
31	SUND'Y	5 06	7 05	3 38

AUGUST.

MOON'S PHASES.

New Moon, 2d. 6h. 23m. M.
First Quarter. 10d. 9h. 47m. M.
Full Moon, 17d. 5h. 26m. M.
Last Quarter, 23d. 9h. 54m. A.
New Moon, 31d. 9h. 58m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Monday	5 07	7 05	4 33
2	Tuesday	5 08	7 04	sets
3	Wednes	5 08	7 03	7 25
4	Thursd'y	5 09	7 02	7 54
5	Friday	5 10	7 01	8 23
6	Saturd'y	5 11	7 00	8 52
7	SUND'Y	5 12	6 59	9 21
8	Monday	5 13	6 58	9 52
9	Tuesday	5 14	6 57	10 28
10	Wednes	5 15	6 55	11 07
11	Thursd'y	5 15	6 54	11 53
12	Friday	5 16	6 53	morn
13	Saturd'y	5 17	6 52	0 44
14	SUND'Y	5 18	6 51	1 43
15	Monday	5 19	6 50	2 47
16	Tuesday	5 20	6 48	3 56
17	Wednes	5 20	6 47	rises
18	Thursd'y	5 21	6 46	7 38
19	Friday	5 22	6 45	8 16
20	Saturd'y	5 23	6 43	8 55
21	SUND'Y	5 24	6 42	9 34
22	Monday	5 25	6 40	10 17
23	Tuesday	5 26	6 39	11 02
24	Wednes	5 27	6 37	11 50
25	Thursd'y	5 27	6 36	morn
26	Friday	5 28	6 34	0 40
27	Saturd'y	5 29	6 33	1 35
28	SUND'Y	5 30	6 32	2 30
29	Monday	5 31	6 30	3 24
30	Tuesday	5 32	6 29	4 19
31	Wednes	5 33	6 27	5 13

ALMANAC FOR 1864.

SEPTEMBER.

MOON'S PHASES.

First Quarter, 8d. 9h. 40m. A.
Full Moon, 15d. 0h. 59m. A.
Last Quart., 22d. 10h. 44m. M.
New Moon, 30d. 2h 33m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Thursd'y	5 33	6 26	6 26
2	Friday	5 34	6 25	6 56
3	Saturd'y	5 35	6 23	7 24
4	SUND'Y	5 36	6 22	7 57
5	Monday	5 37	6 20	8 29
6	Tuesday	5 38	6 18	9 07
7	Wednes	5 39	6 17	9 49
8	Thursd'y	5 40	6 15	10 37
9	Friday	5 41	6 13	11 30
10	Saturd'y	5 41	6 12	morn
11	SUND'Y	5 42	6 10	0 29
12	Monday	5 43	6 09	1 35
13	Tuesday	5 44	6 07	2 43
14	Wednes	5 45	6 06	3 52
15	Thursd'y	5 46	6 04	rises
16	Friday	5 47	6 03	6 47
17	Saturd'y	5 48	6 01	7 28
18	SUND'Y	5 49	5 59	8 11
19	Monday	5 50	5 58	8 57
20	Tuesday	5 51	5 56	9 46
21	Wednes	5 52	5 54	10 36
22	Thursd'y	5 52	5 53	11 30
23	Friday	5 53	5 51	morn
24	Saturd'y	5 54	5 50	0 24
25	SUND'Y	5 55	5 48	1 19
26	Monday	5 56	5 46	2 14
27	Tuesday	5 57	5 45	3 07
28	Wednes	5 57	5 43	4 02
29	Thursd'y	5 58	5 42	4 57
30	Friday	5 59	5 41	sets
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OCTOBER.

MOON'S PHASES.

First Quarter, 8d. 7h. 27m M.
Full Moon, 14d. 10h. 5m. A.
Last Quart., 22d. 3h. 17m. M.
New Moon, 30d. 7h. 18m. M.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Saturd'y	6 00	5 39	6 00
2	SUND'Y	6 01	5 37	6 31
3	Monday	6 02	5 36	7 09
4	Tuesday	6 03	5 34	7 48
5	Wednes	6 04	5 33	8 34
6	Thursd'y	6 05	5 31	9 25
7	Friday	6 06	5 30	10 21
8	Saturd'y	6 07	5 28	11 22
9	SUND'Y	6 08	5 27	morn
10	Monday	6 09	5 25	0 26
11	Tuesday	6 09	5 24	1 33
12	Wednes	6 10	5 23	2 42
13	Thursd'y	6 11	5 22	3 53
14	Friday	6 12	5 20	5 04
15	Saturd'y	6 13	5 19	rises
16	SUND'Y	6 14	5 18	6 46
17	Monday	6 15	5 16	7 34
18	Tuesday	6 16	5 15	8 28
19	Wednes	6 17	5 13	9 20
20	Thursd'y	6 18	5 12	10 15
21	Friday	6 19	5 10	11 10
22	Saturd'y	6 20	5 09	morn
23	SUND'Y	6 21	5 07	0 05
24	Monday	6 22	5 06	1 00
25	Tuesday	6 23	5 05	1 55
26	Wednes	6 24	5 04	2 50
27	Thursd'y	6 25	5 02	3 44
28	Friday	6 26	5 01	4 41
29	Saturd'y	6 27	5 00	5 38
30	SUND'Y	6 28	4 59	6 36
31	Monday	6 29	4 58	sets

ALMANAC FOR 1864.

NOVEMBER.

MOON'S PHASES.

First Quart., 16d. 3h. 43m. A.
Full Moon. 13d. 9h. 23m. M.
Last Quart., 20d. 11h. 6m. A.
New Moon, 28d. 11h. 7m. A.

Days o M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Tuesday	6 30	4 57	6 32
2	Wednes	6 32	4 56	7 22
3	Thursd'y	6 33	4 55	8 16
4	Friday	6 34	4 54	9 16
5	Saturd'y	6 35	4 53	10 18
6	SUND'Y	6 36	4 52	11 22
7	Monday	6 37	4 51	morn
8	Tuesday	6 38	4 50	0 29
9	Wednes	6 39	4 49	1 36
10	Thursd'y	6 41	4 49	2 44
11	Friday	6 42	4 48	3 53
12	Saturd'y	6 43	4 47	5 03
13	SUND'Y	6 44	4 46	rises
14	Monday	6 45	4 45	6 12
15	Tuesday	6 46	4 44	7 07
16	Wednes	6 47	4 43	8 02
17	Thursd'y	6 49	4 42	8 58
18	Friday	6 50	4 41	9 54
19	Saturd'y	6 51	4 40	10 51
20	SUND'Y	6 52	5 40	11 45
21	Monday	6 53	4 40	morn
22	Tuesday	6 53	4 39	0 40
23	Wednes	6 54	4 39	1 34
24	Thursd'y	6 55	4 39	2 29
25	Friday	6 56	4 39	3 26
26	Saturd'y	6 57	4 39	4 24
27	SUND'Y	6 58	4 38	5 24
28	Monday	6 59	4 38	6 24
29	Tuesday	6 59	4 38	sets
30	Wednes	7 0	4 38	6 09
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DECEMBER.

MOON'S PHASES.

First Quart., 5d. 11h. 24m. A.
Full Moon, 12d. 11h. 2m. A.
Last Quart, 20d. 8h. 52m. A.
New Moon, 28d. 1h. 11m. A.

Days of M	Days of Week	Sun Rise h m	Sun Sets h m	Moon R & S h m
1	Thursd'y	7 01	4 38	7 08
2	Friday	7 02	4 37	8 11
3	Saturd'y	7 03	4 37	9 16
4	SUND'Y	7 04	4 37	10 21
5	Monday	7 05	4 37	11 27
6	Tuesday	7 06	4 37	morn
7	Wednes	7 07	4 37	0 34
8	Thursd'y	7 08	4 37	1 40
9	Friday	7 10	4 36	2 48
10	Saturd'y	7 11	4 36	3 54
11	SUND'Y	7 11	4 36	5 00
12	Monday	7 12	4 36	6 02
13	Tuesday	7 12	4 37	rises
14	Wednes	7 13	4 37	6 44
15	Thursd'y	7 13	4 37	7 42
16	Friday	7 14	4 38	8 38
17	Saturd'y	7 15	4 38	9 35
18	SUND'Y	7 16	4 38	10 29
19	Monday	7 16	4 39	11 24
20	Tuesday	7 17	4 39	morn
21	Wednes	7 17	4 40	0 18
22	Thursd'y	7 18	4 40	1 14
23	Friday	7 18	4 41	2 10
24	Saturd'y	7 19	4 41	3 08
25	SUND'Y	7 19	4 42	4 07
26	Monday	7 19	4 43	5 07
27	Tuesday	7 20	4 43	6 06
28	Wednes	7 20	4 44	7 01
29	Thursd'y	7 20	4 45	sets
30	Friday	7 20	4 46	7 04
31	Saturd'y	7 20	4 46	8 11

A MANUAL

FOR

THE PROSPECTOR, THE MINER,

AND

THE ASSAYER.

"*Multa in paucis.*"

PREFACE.

The attention of the majority of the population of California is, at the present time, more or less directed towards the mineralogical resources of the country; the daily discoveries which have been made of the various metals have given birth to a new era for California; numerous prospectors explore the vast mineral regions, while others devote their time to the assaying of the ores; in view of these facts we have thought that a manual, containing in a condensed form the most approved processes for testing the ores, the best methods for assaying the same, and all the information necessary to serve as a guide, would be acceptable, and supply a want most generally felt by those interested in, or devoted to such pursuits.

The present volume is useless to those who *know;* it will be found a sure guide for those who *wish to know*, and a faithful memento for those who *have known.*

Notwithstanding the large importation of works on mineralogy by each successive steamer, the supply is not equal to the demand; moreover they are very costly, and the price of many of them is beyond the means of the majority.

Of the 600 different minerals described in mineralogical treatises, scarcely a dozen are worked at present, or may be at some future period. We shall therefore confine ourselves to the latter.

The author of this Manual has contributed nothing new to Science; he has merely drawn materials for this little volume from various sources; and by careful selections, trusts he has attained the object he had in view.

HENRY PAYOT.

PRELIMINARY NOTIONS.

With the exception of *elementary bodies*, all minerals are compound substances formed by the combination of the elementaries by two and two, three and three, constituting compounds which are termed *binary*, *ternary*, *quaternary*, &c. It would seem as though the fifty-two simple bodies known should give 1,526 binary compounds; 22,100 ternary, 270,725 quaternary, &c. But nature has considerably limited their number, and does not even appear to have created all the combinations, the existence of which may be suspected and which are produced in the chemist's laboratory, since the number of metals known, and which increases every day, consists only of about 600 different kinds.

In natural *binary* compounds, one of the elements is *always* one of the following twelve, viz:

Oxigen,	Carbon,	Tellurium,
Sulphur,	Phthorium,	Mercury,
Arsenic,	Antimony,	Gold,
Chlorine,	Selenium,	Osmium.

In the *binary* compounds known, including even, according to Beudant, those whose existence we only suspect, one of the binary elements is *always* one of the following oxigenated bodies:

ACIDS.

Antimonic,	Chloric,	Phosphoric,
Antimonious,	Perchloric,	Phosphorous,
Arsenic,	Chromic,	Selenic,
Arsenious,	Iodic,	Sulphuric,
Boric,	Molybdic,	Sulphurous,
Bromic,	Nitric,	Tantalic,
Carbonic,	Nitrous,	Tungstic.

OXIDS.

Aluminic,	Hydrogenic(water),	Stannic (tin),
Chromic,	Manganic,	Titanic,
Iron,	Silicic.	

With this knowledge of the composition of mineral bodies, it will be easy to understand that all that is necessary for the mineralogist who wishes to ascertain to what class a mineral belongs, is to make a chemical assay of a very small portion, in order to discover the elements of which it is composed, independently of their relative quantities, by separating them, and successively testing the character or properties of each.

ON ASSAYING.

There are two principal methods of assaying a substance, viz: by the *dry way*, or by means of heat, and with the blowpipe, or with solid reagents;—and by the *wet way*, that is to say, with liquid reagents;—electricity supplies also a third method of assaying.

[A reagent is any substance which is used to discover another substance which is sought to be obtained.]

1.—ASSAYING BY THE DRY WAY.

The purpose of the different reagents is to binoxidize, entirely or partly, the substance submitted to their action, and to bring it to a state in which certain definite properties may be ascertained; or to free one of its ele-

ments, by uniting with the one with which it was combined; or to decompose insoluble salts by compelling their acid to combine with an alkaline base; or to form glass which, according as it is transparent or opaque, colorless or variously colored, affords as many means of ascertaining the nature of the substance submitted to the test; and, lastly, to form by the agency of heat new compounds which can be acted on by acids.

EXAMPLES: Many minerals submitted to the action of the blowpipe, fuse without the addition of borax, such are garnet and felspar.

Others such as topaz, saline oxidized titanium, &c., melt with borax.

The results obtained by fusion vary with many other substances, for instance, tourmaline and analcime are converted into glass; felspar and mica into enamel, and mesotype into a spongy mass.

When thrown on burning coals, certain mineral substances exhibit phenomena different from each other, hydrochlorate of ammonia and cinnabar are volatilised; and saltpetre explodes; chloride of sodium, [common salt,] and oxide of antimony crackle; sulphate of alumina, borax and sulphate of magnesia, bubble up.

THE BLOWPIPE. By the labors of modern experimenters, an instrument has been perfected which seems to be the natural assistant of the prospector, since by its aid, and without the possession of extended theoretical knowledge, he is enabled to perform, on a small scale, many of the same operations which the business of the metallurgist requires of the latter to carry out, in his furnaces and smelting-pots.

This instrument is the *blow-pipe*, which, with its essential accompaniments, furnishes the experimenter with a powerful but delicate blast furnace that is under the most perfect control, and is capable, in a very short time, with the aid of a few simple reagents, of proving the presence or absence of nearly every substance likely to be found among the constituents of ores. The fact that the blow-pipe and its necessary suite of

instruments and reagents are so easily obtained, and so compact, and that the ordinary student may gain (without the aid of a teacher) a considerable skill in their use; and further that their applications are so numerous, and the results obtained so trustworthy, that they are often capable of taking the place of a complete chemical laboratory, — makes their description, and directions for their use, in a work like this, especially appropriate.

The metals that by this process may be most accurately separated and estimated, are silver, gold, lead, copper, tin, bismuth, cobalt and nickel.

In most cases where it is desired to discover only the elementary constitution of minerals, or to execute *qualitative analysis*, a common wax, stearine or tallow candle will answer every purpose. If a lamp is used, the wick should be of cotton and half an inch wide, and must be kept cleanly and evenly trimmed. As a burning material for a lamp, refined rapeseed or olive oil may be used, or, what is still better, a mixture of one part of oil of turpentine with twelve parts of strong alcohol.

Besides this oil lamp, a small *alcohol lamp* for heating the substances in glass tubes, will be found necessary; also the following:

1. Platinum wires, about one fifth of a line in diameter, and two and half inches long, used for holding substances while being melted with borax and other glass fluxes. They should be curved at one end into a loop, that the bead which adheres to them may be more securely held.

2. Glass tubes closed at one end, about one fourth of an inch in diameter and 3 inches long, and made of thin glass, that they may not break in the heat. These are used to heat substances in, over the alcohol lamp, in order to determine the presence of water, sulphur, arsenic and other volatile elements.

3. Glass tubes open at both ends, about one fouth of an inch in diameter and four and half inches long, also made of thin glass, for the purpose of observing the effects of the air upon substances exposed in its presence

to a high temperature. A bit of the substance to be tested must be placed in the tube, which is then held at a slight angle with the horizon, and heated over the alcohol lamp.

4. Forceps of brass, with platinum points, for holding splinters of a mineral in the flame while determining the color produced by a high heat, and the smeltability.

5. A small smooth *block of steel* and a small *hammer* for proving the malleability of globules and breaking ores.

A number of pieces of well burned homogeneous *charcoal*, made from fine grained wood.

6. A small *magnet*, to test for iron, nickel and cobalt.

7. Besides the above, it will be found useful to possess several small and thin porcelain dishes, two or three glass funnels, a small flask for holding water, a wooden stand for test tubes and one for filtering, and a quire or two of filter paper.

Reagents. The reagents to be used with the blowpipe should be kept in small glass bottles with ground stoppers. They are:

1. Soda (carbonate of soda): for reducing metallic oxides to the condition of metals, and for determining the presence of sulphur and silica.

2. Neutral oxalate of potash furnishes a still more efficient means of reducing the metallic oxides.

3. Borax (biborate of soda) has the property of forming a transparent glass, which becomes variously colored by the addition of different substances.

4. Salt of phosphorus (phosphate of soda and ammonia) is used in the same manner as borax, but often produces a peculiar reaction. Numbers 3 and 4 are sometimes called the glass fluxes.

5. Bisulphate of potash, for testing for the presence of boracic acid, chlorine, nitric acid, etc.

6. Saltpetre (nitrate of potash) for testing for manganese.

7. Nitrate of cobalt in solution, for distinguishing between magnesia and alumina, and zinc and tin.

8. Pure lead, for the gold and silver assay.

9. *Finely powdered bone ash*, to be used for absorbing the oxide of lead in the gold and silver assay.

10. *Sulphuric acid*, *hydrochloric acid*, *nitric acid*, and *ammonia.*

By means of this instrument the flame of a spirit lamp is driven by blowing on to the fragment of ore which is to be submitted to the action of heat.

The student of blowpiping must first apply himself to produce a steady blast, and to generate and distinguish between the different sorts of flames. The operation of blowing should not be performed by the lungs, but with the muscles of the cheeks; the air is furnished as required to the cavity of the mouth, but breathing should proceed undisturbed through the nose.

The flame of the blowpipe possesses besides the property of furnishing a very strong heat, that of acting as a powerful chemical reagent, and as such it must be chiefly studied.

When we examine the flame of a common candle we discover that it is composed of four parts. At the base is a small crescent with a clear blue color; higher up and in the centre of the flame, a dark cone; surrounding this a luminous cone; and externally and surrounding the whole is a scarcely perceptible conical mantle. The student has to remark the nature of two of these divisions: the exterior non-luminous conical mantle, which is composed of gases already saturated with oxygen, that under certain circumstances goes over to bodies with which the flame is brought in contact, and for that reason constitutes the *oxidizing flame;* and secondly, the luminous cone, which consists of gases not yet saturated with oxigen, and therefore capable of extracting the element from easily reducible oxides, and for that reason called the *reducing flame.*

When the point of the blow-pipe is held about one third of the breadth of the wick in the lamp flame, a

flame is produced by blowing that is long, slender and blue, is hottest at the outermost point and is an oxidizing flame. This action, however, is strongest a slight distance from the visible point of the flame, in the stream of heated gas.

If now the point of the blow-pipe be held somewhat higher than before, and not quite within the flame, a larger and more luminous cone of burning gases may be driven in a slightly oblique direction; within the bright portion of the flame and a short distance from its point, the above mentioned chemical action on oxides takes place, which causes this to be called the *reducing flame.*

In the examination of mineral substances, the composition of which the prospector wishes to discover, he should pursue a regular course as follows: 1. Heating the mineral in a closed glass-tube. 2. Heating in an open tube. 3. Trying in forceps before the oxidizing flame to discover the color of the light produced. 4. Heating the substance alone on coal to observe whether it is volatile, and what kind of a sublimate it forms, and moistening the substance or sublimate with cobalt solution to bring out a characteristic color. 5. Melting with borax and salt of phosphorus (glass fluxes) upon platinum wire, to observe the colors produced. 6. Tests in the wet way with acids and other reagents.

During this course of experiments, phenomena will generally be observed which will decide the nature of the substances present.

Distinguishing characteristics of a few substances submitted to the action of the blowpipe.

1. *Sulphur.* When heated in an open glass tube, ores containing sulphur generally give off fumes of sulphurous acid, similar to those perceived when a common match is lighted. If a substance containing sulphur be melted with pure soda, and the mass brought upon a

clean silver coin and moistened with water, a dark spot is formed.

2. *Selenium.* When a small fragment of a mineral containing selenium is heated on charcoal, an odor is observed similar to that of rotten horse radish.

3. *Phosphorus* gives, when the substance that contains it is moistened with sulphuric acid and held in the forceps, a green tinge to the flame.

4. *Chlorine.* By saturating a bead of salt of phosphorus on a platinum wire with the oxide of copper, and then adding the mineral supposed to contain chlorine, in case of its presence a deep blue color will be given to the flame.

5. *Fluorine.* By heating a substance containing this element in a glass tube with salt of phosphorus, the interior surface of the glass becomes etched or roughened.

6. *Arsenic* in its various compounds gives a garlicy odor, and a white vapor when heated on charcoal.

7. *Antimony* gives upon charcoal a white sublimate, but develops no *odorous* fumes.

8. *Copper* gives with borax upon platinum wire and in the oxidizing flame a greenish bead, which on cooling becomes blue: in the reducing flame this bead becomes red with the suboxide. When its solution in acids is saturated with ammonia, a beautiful deep blue color is produced.

9. *Bismuth* gives on charcoal a sublimate which while hot is dark orange-yellow, but when cooled, becomes citron-yellow.

10. *Tin*, when heated on charcoal, forms a white coating, which settles close around the assay, and reduces to metallic globules when treated with the reducing flame. With cobalt solution this coating becomes bluish-green.

11. *Lead* forms a yellow coating on charcoal, which in the reducing flame changes its place with the exhibition of a bluish light.

12. *Zinc* gives a yellow coating on coal, which upon

cooling becomes white. When this coating is moistened with cobalt solution and heated in the oxidizing flame, a yellowish-green color is produced.

13. *Nickel.* In the oxidizing flame and upon platinum wire, with borax, the compounds of this metal give a reddish-brown bead. The nickel reduces easily in the reduction flame, giving these beads a grey color.

14. *Cobalt* gives, with borax and salt of phosphorus in the oxidizing and reducing flames, a beautiful blue bead.

15. *Iron.* The compounds of this metal give, with borax, upon platinum wire and in the oxidizing flame, while hot, a reddish, when cold a yellow bead, which in the reducing flame becomes bottle green.

16. *Quicksilver*, when in combination, if heated in a closed glass tube with oxalate of soda, a grey metallic sublimate collects in the upper portions of the glass.

17. *Manganese* gives, with borax, in the oxidizing flame, an amethyst-red bead, which when heated in the reducing flame becomes colorless.

18. *Alumina*, when treated on charcoal, moistened with cobalt solution and brought to a glowing heat, becomes blue.

19. *Soda*, in any of its compounds, gives the blowpipe flame an intense yellow color.

20. *Silver.* This metal is best sought for by melting the compound supposed to contain its after roasting, when necessary — with test lead, and then bringing the globule produced, which will hold all the silver present, upon a layer of bone ash. By a continual oxidizing flame the lead may be oxidized and driven in to the ash, and the pure silver that remains behind, in the form of a bright grain, may be proven by its malleability beneath the hammer. This method of separating lead from silver is called cupelling.

21. *Gold.* To discover gold in combination with other metals, as copper, etc., the substance should be cupelled; the globule obtained will be recognized by its color and malleability. When however silver is present in any

quantity, the globule obtained will be white. In this case the silver may be dissolved out in nitric acid, and the gold will remain behind.

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2.—ASSAYING BY THE WET WAY.

It is requisite for assaying by the wet way, that the minerals should be previously dissolved. A small number are soluble in water, some can be acted on by acids; others must be first melted with carbonate of soda, which forms an alkaline salt soluble in water, and a carbonate of the bases which is soluble in the acids. Finally, other substances require to be previously melted with soda, so as to dissolve in water, or better in acids.

EXAMPLES: If we submit carbonate of lime and sulphide of tin to the action of acids, and particularly to that of nitric acid, those two substances effervesce while dissolving, whereas phosphate of lime and phosphate of magnesia do not, and mesotype and carbonate of zinc assume a gelatinous form.

The reagents in use for discovering the nature of minerals are dry or liquid.

DRY REAGENTS:

Borax,
Nitrate of baryta,
" of potassa,
Double phosphate of soda and ammonia,
Sub-carbonate of soda,
Copper filings,
Slips of copper,
" of iron,
" of tin,
" of zinc,
Thin sheets of tin,
Proto-chloride of tin,
Proto-sulphate of iron.

LIQUID REAGENTS:

Hydro-chloric acid,
Hydro-sulphuric acid,
Nitric acid,
Sulphuric acid,
Alcohol,
Ammonia,
Hydro-sulphate of ammonia,
" " of potassa,
Infusion of galls,
Nitrate of silver,
" of baryta,
" of cobalt,

Lime water,	Nitrate of lead,
Distilled water,	Caustic potash,
Hydro-chlorate of ammonia,	Oxalate of ammonia,
" of platinum,	Caustic soda,
Hydro-cyanate of iron and potassa,	Carbonate of ammonia,
	Sulphate of soda.

METHODS FOR ASCERTAINING the nature of a metal.

I.

If the metal decomposes water at the ordinary temperature, and causes effervescence, its nature can be ascertained by saturating it with hydro-chloric acid, and concentrating the salt thus produced, which will show that the metal is :

1st. Potassium, if the saline solution remains limpid when treated by the solutions of the sub-carbonates of soda, potassa or ammonia, and if it is rendered turbid by those of platinum and sulphate of alumina.

2d. Sodium, if the three preceding saline solutions, and those of platinum and sulphate of alumina do not render it turbid, and if it leaves, after evaporation, a salt crystallizing in cubes of a saltish taste.

3d. Barium, if sulphuric acid produces in the solution diluted with a large quantity of water, a white precipitate, insoluble in an excess of the acid, and after concentration leaves square crystalline scales insoluble in alcohol.

4th. Strontium, if the solution affords crystals of slender prisms soluble in alcohol, and communicate to flame a fine red tint, and if the diluted solution does not precipitate by sulphuric acid.

5th. Calcium, if the diluted solution does not precipitate by the sub-carbonates of ammonia, potassa, soda and sulphuric acid, but precipitates by oxalic acid, producing a salt by evaporation which is not deliquescent, and crystallizes with difficulty.

6th. Lithium, if the above mentioned sub-carbonates make its solution turbid when it is concentrated; if no precipitate is formed by oxalic and sulphuric acids, and with any of the oxalates and sulphates, and if it does not act on platinum foil when heated with a small quantity of soda.

II.

If the metal has no action on water at the ordinary temperature, but dissolves in dilute sulphuric acid, and evolves hydrogen gas, it is:

1st. Cadmium, if a white precipitate is formed in the sulphuric solution by ammonia, potassa or soda; soluble in ammonia, but not in soda and potassa; and, lastly, if a yellow or orange colored precipitate is obtained by sulphuric acid or the hydro-sulphates.

2d. Iron, if chlorine, having been previously added to the sulphuric solution, a black precipitate is obtained with the solution of galls, and a blue precipitate with the hydro-cyanates of iron and soda or potassa; or if any of the alkalies determine in the sulphate, a whitish precipitate, which assumes a dark green color when exposed to the air.

3d. Manganese, if the precipitate of the sulphuric solution obtained by potassa or soda is white and insoluble in an excess of these alkalies; if it assumes a dark brown color when in contact with the air; if it gives a white precipitate with the alkaline hydro-sulphates; and finally, if the precipitate obtained by the alkalies, being calcined in a platinum crucible with hydrate of potassa, produces the combination of fixed alkaly and manganese, called mineral chameleon.

4th. Zinc, if the white precipitate formed in the sulphuric solution by the alkalies remains white in contact with the air, and is redissolved by adding to the solution an excess of the alkalies; finally, if a whitish precipitate is obtained with hydro-cyanate and hydro-sulphate of potassa.

III.

If water, or diluted sulphuric acid has no action on the metal at the ordinary temperature; but if it is acted on by nitric acid, either cold or hot, it will be one or several of the following metals: silver, antimony, arsenic, bismuth, cobalt, copper, tin, mercury, molybden, nickel, palladium, lead, tellurium, uranium.

A — Cobalt, copper, nickel, palladium and uranium are easily distinguished from the other metals, because their nitric solutions present the following colors:

1st. Solution of COBALT: violet-red, giving a violet blue precipitate by the alkalies, green by the hydro-cyanates of potassa and soda, and black with the hydro-sulphates.

2d. Solution of COPPER: greenish-blue; by the alkalies it gives a blue precipitate insoluble in an excess of these bases; a bluish-white precipitate with ammonia; an excess of the latter redissolves it in the liquid, imparting to it a beautiful blue color, called "celestial blue;" if a bright slip of iron be dipped in the solution, its surface will be covered with a coating of copper.

3d. Solution of NICKEL: meadow-green; its precipitate by the alkalies is a grass green; ammonia imparts to it a violet blue color; the precipitate is black with hydro-sulphate of potassa, and apple green with the hydro-cyanate of iron and potassa.

4th. Solution of PALLADIUM: red; the metal is speedily reduced by proto-sulphate of iron; with the hydro-cyanate of iron and potassa, the precipitate is of an olive color; the salt and the oxide are decomposed with the assistance of heat.

5th. Solution of URANIUM: a yellowish color; its precipitate with the alkalies is of a light yellow; of a blood colored red with the hydro-cyanate of iron and potassa; the solution, when concentrated, yields lemon colored crystals.

B — The colorless solutions obtained by cold or hot nitric acid, denote the following metals:

1st. Silver, when hydrochloric acid produces a precipitate insoluble in excess of that acid, but easily dissolved in ammonia; and when a white precipitate is obtained by alcohol, which, when dried, explodes if struck or heated.

2d. Arsenic, when the mineral is volatile, when it emits white vapors and a strong smell of garlic, if thrown on burning coals; a precipitate of a beautiful yellow color is obtained from its nitric solution with hydro-sulphuric acid.

3d. Antimony. This metal is but slightly acted on by concentrated nitric acid, it does not dissolve it; it is soluble in chloro-nitric acid, from whence it may be precipitated in the form of a white oxyde by water, and by hydro-sulphuric acid of an orange-red.

4th. Bismuth, nitric solution; its precipitate obtained by addition of water is white, and black by hydro-sulphuric acid.

5th. Tin. Slightly acted on by nitric acid; it dissolves in hydro-chloric acid, evolving hydrogen gas; it produces two hydro-chloric salts, which are not decomposed by water; one of these salts gives a pale yellow precipitate with sulphuric acid, without any action on solutions of gold; the other gives with the same acid, a brown precipitate, and forms in gold solutions a precipitate known as the "Purple of Cassius."

6th. Mercury. It sublimates by distillation; its nitric solution imparts a white coating of metal to a slip of copper immersed in it.

7th. Molybden is not dissolved by nitric acid, but converted by it, into a white powder soluble in water, and which reddens a solution of litmus, and forms salts with the alkalies; this is molybdic acid.

8th. Lead. This solution has a sweetish taste, and forms white precipitates by the sulphates and sulphuric acid, and black by hydro-sulphuric acid.

9th. Tellurium, is easily fused, very volatile, and burns with a blue color in the flame of the blowpipe; the oxide which is produced sublimates and emits a

smell similar to that of horse radish; its nitric solution supplies a precipitate of an orange brown, with hydro-sulphuric acid.

IV.

If the metal is but very slightly acted on by boiling concentrated nitric acid, and if dissolved by hydro-chloro nitric acid, it is:

1st. Cerium, if it is soluble in hot hydro-chloro nitric acid; if after expelling the greater part of the excess of hydro-chloro nitric acid of the solution, the latter colorless and of a sweetish taste; if the solution gives with the alkalies a white precipitate insoluble in an excess of the alkalies; if no change is apparent in this solution by the addition of an infusion of galls and hydro-sulphuric acid; if a white precipitate is formed by the hydro-cyanate of iron and potassa; and if the white oxyde precipitated by the alkalies after being heated in a platinum crucible, takes a reddish-brown color and increases in weight.

2d. Gold, if when dissolved in *aqua regia*, the solution is yellow; when it gives a purple or violet, or a very dark brown precipitate with the hydro-chlorate of protoxide of tin; a yellow brown with the proto-sulphate of iron, which after calcination presents itself in the form of unburnished gold; a yellowish precipitate by ammonia, which explodes violently when dry and heated.

3d. Osmium. If the metal oxydizes and sublimates when heated, emitting an odor of chlorine; if equal parts of this metal and of nitrate of potassa are calcined in a retort, they will produce a white sublimate, having the odor of chlorine, it is very caustic, and accelerates the combustion of charcoal. Its solution in *aqua regia*, takes a blue color with an infusion of galls.

4th. Platinum. If the solution in *aqua regia* is of an orange tinted yellow, and if the proto-sulphate of iron, and hydro-chlorate of tin have no very decided action on it; when concentrated, ammoniacal salts and those of potassa produce yellow precipitates, which are more or

less soluble in water; the precipitate obtained by hydro-chlorate of ammonia, assumes by calcination the form of small metallic white grains.

5th. TUNGSTEN. If the product obtained by calcining it with equal parts of nitrate of potassa, is soluble in water; if this solution is colorless; if a white precipitate is obtained by nitric acid, the latter, if heated, colors it yellow, and converts it into an acid.

If all the foregoing reagents have no action on the metal, the latter is:

1st. COLUMBIUM. If a substance is obtained by calcining with nitrate of potassa, which abandons the nitric acid, weakens the potassa, and leaves a residue of columbic acid.

2d. CHROMIUM. If the yellow substance obtained by calcining it half an hour with nitrate of potassa, imparts its color to water; if the solution previously neutralized by nitric acid, produces:

In acetate of lead, a bright yellow precipitate;

In nitrate of silver, a purple precipitate;

In the acid nitrate of mercury, a red precipitate;

3d. IRIDIUM, on which the hydro-chloro-nitric acid has scarcely any action; when calcined with nitrate of potassa, it gives a black substance, which colors water blue; that which has not affected the liquid, united with hydro-chloric acid, produces a blue hydro-chlorate, which heated in air, is successively colored green, violet purple and yellowish red.

4th. RHODIUM, infusible at all temperatures, even in the flame of the oxygen blowpipe; not acted on by hydro-chloro-nitric acid; when calcined with nitrite of potassa, the product dissolves in hydro-chloric acid, and the solution is red. The hydro-chlorates of ammonia, potassa and soda combine with this solution, and produce salts with double bases of a pink color, which crystallize easily and are insoluble in alcohol.

5th. TITANIUM, if its copper red color is converted into blue by calcination in air; if after calcination with its

own weight of nitrate of potassa, the product being repeatedly washed with water, is soluble in hydro-chloric acid, and if the solution is of a light yellow color, after the excess of hydro-chloric acid has been expelled by evaporation; if from this solution is obtained:

With the alkalies, a white precipitate;

With an infusion of galls, an orange red precipitate;

With the hydro-cyanate of iron and potassa, a reddish brown precipitate.

With the hydro-sulphate of potassa, a light green precipitate.

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We shall now proceed to describe the method of analyzing a mineral by the "wet way," supposing it to contain various substances from which we wish to extract the metals that are commercially valuable.

The ore must first be reduced to a very fine powder, and sifted; the portion which remains on the sieve, to be pulverized again. It is essential that the *whole* of the lump of ore to be analyzed should be reduced to powder.

To this add nitric acid, and evaporate to dryness.

Then treat it with water. The lead, copper, zinc and silver will constitute the solution.

The tin, gold and platinum will form the residue; the tin will be an oxyde of tin, and the two other metals will be in the metallic state.

The oxyde of tin can be dissolved by hydro-chloric acid.

To the residue of gold and platinum add chloro-nitric acid.

The gold will be reduced from the solution by the proto-sulphate of iron.

The platinum will remain in the solution.

The lead, copper, zinc and silver may be separated from the solution in the following manner:

The lead, by addition of sulphuric acid, will form a sulphate.

After removing this precipitate, by adding hydro-

chloric acid, the silver will be precipitated as chloride of silver.

The solution will then contain the copper and zinc.

The copper may be separated in the metallic state by means of a slip of iron, having a clean bright surface.

The solution will then only contain the zinc, which must be peroxydized by nitric acid, and then precipitated by excess of caustic potash, and the zinc will re-dissolve in the liquor.

To obtain the oxyde of zinc, saturate the solution with due proportions of an acid.

The preceding process may serve to discover the various metals contained in a piece of metallic ore; but if only one metal which we know, or believe to be contained in it, is sought to be obtained, the pulverized rock must be submitted to the analysis specified for each one of the metals we shall now proceed to describe.

DESCRIPTION OF THE DIFFERENT METALS

THAT MAY BE PROFITABLY WORKED IN CALIFORNIA, AND OF THE DIFFERENT FORMS IN WHICH THEY ARE FOUND IN NATURE.

SILICA.—SILICIC ACID.

Silica is generally known as quartz, or rock crystal. It forms a part, or enters into the composition of a particular kind of stony substances capable of forming glass with the alkalies. It is the basis of all precious stones, except the diamond, the sapphire and spinel ruby.

Pure silica is an oxyde, white, infusible, and scratches metals; it is insoluble in most of the acids; it combines with bases, so as to partake of the nature of acids rather than of that of oxydes; it is slightly soluble in water. Silica may be divided into two kinds: quartz, or anhydrous silica, that is, deprived of water, and opal, or hydrated silica, or containing water. We shall devote our attention only to the former.

QUARTZ.—ANHYDROUS SILICA.

This substance is opaque, translucent, or transparent, and frequently of the most brilliant and varied colors. it possesses a considerable, though variable degree of hardness, and crystallizes in the rhombohedral system; infusible alone by the blowpipe, but easily melted with the assistance of borax or caustic alkali into a clear, transparent glass. Its hardness is in general considerably greater than that of either steel or glass.

Composition	Silicium.....	48.05
	Oxygen.....	51.95
		100.00

The GANGUE of the majority of minerals consists of quartz. These veins of quartz are very abundant, and their outcroppings can be traced for a distance of several miles, and may and do serve as a guide to the miner in search of the precious or useful metals.

The gangue generally partakes of the color of the metals or metallic compounds, which it contains. If the metal is in small quantity, the quartz retains its color; it loses it as the quantity of metal increases, and when very abundant, the quartz is entirely colored with the metallic compound. In many cases the color of the gangue is sufficient indication of the metal it contains, especially if they are sulphurets and oxydes.

COPPER.

Copper occurs in nature in four principal states: native copper, oxyde of copper, in combination with combustibles, especially sulphur, and in the saline form.

NATIVE COPPER. It is a metallic substance, of a red color, ductile, malleable; it crystallizes in the octohedron and prismatic systems. Its specific weight is 8.89; it melts at 1,996 (Daniel), (27° Wedgwood). Dry air has no action on copper at the ordinary temperature; in contact with moist air it is converted into green oxyde, which combining with the carbonic acid of the atmo-

sphere, converts it into the sub-carbonate of copper, observable on bronze statues. In contact with silver it develops electric fluid, and it always forms the negative pole of a battery.

The characteristic property of copper is its solubility in nitric acid, producing effervescence and coloring the liquid green, owing to the decomposition of a portion of the acid and to the oxydation of the metal.

A black precipitate is produced in an acid solution of a salt of copper by sulphuretted hydrogen, and by iodide of potassium, a white precipitate which is insoluble in hydro-chloric acid; the copper precipitates in the metallic state with iron and zinc.

Native copper occurs generally in primitive or transition soils. The usual gangues of copper are granite, gneiss, micaceous and argilaceous schist; carbonated and fluated lime, sulphate of baryta, etc.

Sulphuret of copper, (vitreous copper). A metalloid substance, of an iron grey color and one of the richest ores of copper. Fusible by the blowpipe, and even in the flame of a common candle; it is soft enough to be cut with a knife; its fracture is conchoidal—it yields metallic grains of copper when fused with soda—it is soluble in nitric acid, copper being precipitated from the solution by a slip of iron.

Copper pyrites. It is the most important of all the copper ores, and the most abundant in nature. It is a combination of sulphur, copper and iron which contains 34 per cent. of copper. It is of a brass yellow color, having occasionally a variegated surface. Its fracture is conchoïdal and of metallic lustre; it is found crystallized, mostly in truncated tetrahedrons; is brittle, and does not strike light with iron, and is of a darker shade than the latter mineral. It is frequently associated with other sulphurets of copper, lead, iron and zinc, etc., and often contains gold and silver.

Variegated copper ore is a combination of the sulphurets of copper and iron; its color is a bronze yellow, being an intermediate between copper red and tombac

brown, with an irridescent surface and metallic lustre. This ore is very abundant; its crystals are rare; fusible by the blowpipe, affording globules which are attractable by the magnet, and copper when fused with soda.

Grey copper ore. This name is given to a combination, in various proportions, of sulphur, antimony, arsenic, copper, iron, sometimes zinc, and frequently silver. Its color varies from iron grey to lead grey; it has a metallic lustre and crystallizes in tetrahedrons; this is a very valuable ore, in which the proportion of silver sometimes amounts to 17 per cent. Fusible by the blowpipe, emitting antimonial vapors, and often arsenic; attacked by nitric acid; the solution gives a blue precipitate by the hydro-cyanate of iron and potassa.

Bournonite is a combination of sulphur, copper, antimony, iron and lead, of a lead color and metallic lustre. This mineral is more rarely met with than the preceding ones. Fusible by the blowpipe, producing at the same time antimonial vapors, a yellow oxide, lead and a button of copper. Soluble in nitric acid, from which a precipitate of an intense blue color is obtained by addition of ammonia.

Protoxyde of copper, (ruby copper, red oxide of copper). This ore is of a fine crimson color, brittle and as hard as fluorspar; it crystallizes in octahedrons and dodecahedrons. Detached crystals have the appearance of spinel rubies. Fusible by the blowpipe into a black substance in the oxidizing flame, and into globules of copper in the reducing flame; acted on by nitric acid.

Tile ore is a mixture of red oxide and hydrate of iron, and is a variety of the former.

Black oxide of copper is of an earthy texture, occurring in the form of a fine black, or blackish brown powder, usually intermixed with copper ores, principally with copper pyrites, on which it forms a coating. It is a compound of binoxide of copper and oxide of hydrate of iron, intermixed in some instances with hydrate of manganese. It is easily reduced on charcoal to metallic copper in globules.

Mysorine (anhydrous carbonate of copper) a dark, brown mineral, found in the province of Mysore, India; fracture conchoidal and lustreless; maculated with green; red and brown, from the admixture of malachite and peroxide of iron. Soft, easily cut with a knife. Soluble in acids, affording an insoluble red deposit. Metallic copper is precipitated from the solutions on a piece of clean iron immersed in them. It occurs in earthy or compact masses.

Azure copper ore (blue carbonate of copper). Of a beautiful dark blue color, generally crystallized in oblique rhombic prisms, somewhat modified; and when pure the crystals are semi-transparent and vitreous.

Green carbonate of copper (malachite). This ore differs from the blue carbonate. The latter contains less copper. It is of a beautiful bright green, and contains more water and copper than the azure ore, and less carbonic acid. It is rarely crystallized, its texture being either lamellated, fibrous, compact or earthy.

Erinite (copper mica—arsenite of copper). It occurs in thin transparent hexagonal crystals, resembling plates of mica of a deep emerald green, reducible by the blowpipe to a white metallic globule; attacked by nitric acid. It contains 59 per cent. of oxide of copper, with arsenious acid and water.

Liroconite (lenticular copper ore). Arseniate of copper; crystallizes in very obtuse rectangular octahedrons, of a light greenish blue; fusible by the blowpipe, affording white metallic grains. Soluble in nitric acid, and small scales of copper are deposited on a piece of clean iron immersed in the solution.

Oliven ore (arseniate of copper). The color of this mineral is olive-green. Fusible by the blowpipe, leaving vitreous scoria encasing white metallic grains, with indications of phosphoric and arsenic acids.

Euchroite (arseniate of copper) of an emerald green; crystallizes in rectangular rhomboidal prisms.

Phosphate of copper. It is generally of an intense green color, the crystal being sometimes quite black ex-

ternally. It is reducible by heat, and affords grains of copper by addition of soda.

APHANESITE (arseniate of copper). The crystals are of a bluish green, and become grey on the surface. Reducible by the blowpipe into a button, which crystallizes on the surface.

ATACAMITE (chloruret of copper). This mineral is found in the desert of Atacama, between Chile and Peru, in the form of a fine emerald green sand. It blackens when heated; fusible by the blowpipe, coloring the flame blue and green.

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THE ASSAYING OF COPPER ORES.

BY THE DRY WAY.

If the ore is a sulphuret, it must be washed, in order to oxidize the metals. It is frequently requisite after the first washing to pulverize the ore and submit it to a second washing.

The assay of the oxidized ore is generally made on 50 grains of the mineral, more or less, according to its supposed richness. In general, 20 grains, at least, should be obtained.

The quantity of ore to be assayed is mixed with from one-eighth to one-fourth of an ounce of carbonate of soda, and about one-eighth of an ounce of pulverized charcoal. An earthen crucible is half filled with the mixture; on the surface is put a layer of common salt; a cover is placed on the crucible, taking care to leave apertures around it.

After the matter has remained in fusion about twenty minutes, the crucible is taken from the fire, and if the scoria contain no grains of copper, the metal is rubbed or brushed clean and weighed; the proportion of copper will thus be obtained.

BY THE WET WAY.

The assay by the wet way is more accurate, but requires more skill. Weigh about one-eighth of an ounce

of the ore reduced to a very fine powder and treat it with boiling aqua regia, containing a larger proportion of hydrochloric acid than of nitric acid, or better still with hydrochloric acid alone, if all the copper contained in the ore can be dissolved by it; if the ore contain lead, use sulphuric instead of hydro-chloric acid, to form an insoluble salt of lead; evaporate to dryness, and treat the residue with hydro-chloric acid; add water and filter to separate the gelatinous silica and all the insoluble substances. Heat the filtered solution to nearly the boiling point, and precipitate with a bright piece of iron. Care should be taken to maintain the solution in a state of acidity by occasionally adding hydro-chloric acid to prevent the formation of an insoluble salt of iron, which would otherwise precipitate with the copper.

The precipitate of copper is then quickly and repeatedly washed with boiling water, then washed on a filter until no turbidity is produced in it, when nitrate of silver is added. The copper thus obtained is dried on blotting paper at a moderate heat, and afterwards weighed. If dried at too high a temperature, the copper would combine with a notable quantity of oxygen.

If the ore contains arsenic, a certain quantity is always precipitated with the copper; it may be redissolved by adding hydro-sulphate of ammonia in excess.

SILVER.

The density of silver varies between 10,47 and 10,54; it fuses at 1873°.

It is harder than gold, but less so than copper. It is volatile.

The following are the chemical characteristics of silver:

The fixed alkalies form, in neutral or acid solutions of silver salts, a brown precipitate of oxide of silver, insoluble in excess;

Ammonia redissolves the precipitate;

Ordinary tribasic phosphate of soda forms a yellow precipitate;

Bibasic phosphate of soda forms a white precipitate;

With hydro-sulphuric acid and alkaline sulphides, a black precipitate;

Solutions of silver treated with hydro-chloric acid, or a soluble chloride, yield a white curdy precipitate of chloride of silver, which soon becomes purple, if exposed, while moist, to the direct rays of the sun. This precipitate is not dissolved by nitric acid, but by ammonia, in common with most of the insoluble salts of silver;

Hydriodic acid and soluble iodides form a pale yellow precipitate of iodide of silver, also insoluble in nitric acid, and still less soluble in ammonia;

Sulphate of silver, which is obtained by precipitating it from a solution of nitrate of silver with sulphate of potash, is soluble in 88 times its weight of boiling water. This salt is highly soluble in ammonia;

Nearly all metals precipitate silver from its solutions;

When a soluble salt of silver, in a moist state is rubbed with a piece of zinc, it is decomposed.

NATIVE SILVER. It is a white, ductile, tough, metallic substance, attacked by nitric acid; the solution precipitates silver on a slip of copper immersed in it. In nature it is always more or less associated with other metals, such as copper, lead, etc. It is usually dull externally; but exhibits the brilliancy of silver when scratched. It crystallizes in cubes and regular octahedrons; it is also found in leaves and threads, also in amorphous masses. It occurs principally in veins in primary, but seldom in transition formations, associated with quartz, carbonate of lime, carbonated oxide of iron, galena, etc. Masses of considerable size have been found in Konigsberg, weighing from 100 to 350 pounds. Masses of 200 and 800 pounds were found in Mexico at the close of the last century. From the Johanngeorgenstadt mine a block of massive silver was obtained, weighing nearly 10,000 lb.

ANTIMONIAL SILVER (antimoniuret). A silver-white metalloid substance; crystallizes in rectangular prisms, but more frequently met with in concrete masses. It contains 23 parts of antimony and 77 of silver. Fusible by

the blowpipe, evolving antimonial vapors, and leaving a globule of malleable silver. It is attacked by nitric acid.

Sulphuret of silver (vitreous silver). It is of a dark steel grey color, with metallic lustre, and found both in massive and crystallized forms belonging to the cubic system, the surface of the crystals being often bluish-black or irridescent. Fusible by the blowpipe, with evolution of sulphureous vapors. Soluble in nitric acid. Metallic silver is precipitated from its solution by a piece of copper. This test applies to all silver ores when dissolved in acid. This ore furnishes the principal part of the silver of commerce, and is, with the exception of native silver, the most abundant of its ores. It is generally found in granitic and schistose formations, and in porphyritic deposits.

Red antimonial sulphuret of silver (ruby silver). It crystallizes in rhombohedrons; is attacked by nitric acid; less easily fused, and evolving less white vapors than the black sulphuret. It is found in comparatively small quantity in European mines; but in some parts of Mexico, particularly in the mines of Sombrerete, Cosalá, Zoolga, Vetanegra, etc., dark red silver is the principal ore.

Black antimonial sulphuret of silver (myargyrite). This ore is externally black, of a semi-metallic lustre, and brittle; the fracture is conchoidal; when powdered it appears to be of a very deep red; its crystals are rhombohedrons. Fusible by the blowpipe, emitting white sulphureous vapors; attacked by nitric acid, a piece of copper precipitates metallic silver from the solution. This substance is very rare.

Brittle silver glance. A dark steel-grey colored brittle ore; the crystals are hexagonal prisms, sometimes terminated by pyramids. Reducible by the blowpipe to a bead of silver, the sulphur burning away, and the antimony being volatilized in white fumes. Attacked by nitric acid, with a white precipitate, the solution affording metallic silver on a piece of copper.

Arsenical silver. This substance is distinguished

from native silver by its brittleness and the arsenical fumes which are emitted when heated, leaving by the blowpipe, a metallic silver bead. It is rare.

Sulphuret of iron and silver. This is a brown mineral, crystallizing in small hexahedrons, which bend like thin sheets of tin. It contains: silver, 33; iron, 56, and sulphur, 30.

Polybasite is of a dark steel-grey color, crystallizing in regular hexagonal prisms. Fusible by the blowpipe, with evolution of antimonial fumes, leaving a silver bead. Attackable by nitric acid, leaving a small quantity of precipitate. It is rich in silver and contains sulphur, antimony, arsenic, silver and about 9 per cent. of copper and iron. It is found principally in the mines of Guanajuato and Guarisamey, Mexico.

Chloruret of silver (horn silver, corneous silver ore, kerargyre). This mineral which is similar in appearance to horn mercury or chloruret of mercury, occurs in small irregular masses of a grey or brownish color, or forms a thin crust on other ores. It is translucent, soft and waxy in its texture, and crystallizes in cubes, either simple or with the angles truncated. Insoluble in water, and not volatilized when heated; fusible by the blowpipe, but not easily reduced; when rubbed on a piece of iron or copper moistened with water, it deposits metallic silver. It is rarely met with in European mines; but in some parts of Mexico and Peru, it forms a large portion of the ores called *pacas* and *coloradas*, in which it is mixed with earthy oxide of iron, and penetrated by numerous fine threads of metal.

Such are the different compounds of silver which occur most commonly in nature; but there are several others which contain a notable proportion of silver, and many of them may exist in California, we shall briefly mention them:

Auriferous silver. A metallic substance of a paler yellow color than native gold, inclining to green. This metal has been found in California and Mexico.

Carbonate of silver. A soft ash-grey mineral; when

cut with a knife, it exhibits a bright lustrous surface; is easily reduced by the blowpipe. This substance is very rare, having been met with only in a mine of the Grand-Duchy of Baden, in a gangue of barytine.

Aururet of silver (electrum). This is a native alloy of 64 parts of gold with 36 of silver. It crystallizes in the cubic system. It is met with generally in veins, in Siberia, Hungary and Transylvania, but not often in sand or grains.

Sulphuret of silver and copper (stromeyerine). A metalloid substance of an iron-grey color and metallic lustre. Fusible by the blowpipe, soluble in nitric acid. The copper will be deposited on a knife blade dipped into the solution, and the silver on a piece of copper. It is very brittle. This substance occurs but in few of the great depositories of silver ores, and in very small quantity; it has been found at Schlaugenberg, in Siberia.

Tellururet of silver and gold [graphic gold]. This is a native alloy containing 30 per cent. of gold, 10 of silver and 60 of tellurium. It is of a steel-grey color; its crystals, when perfect, are prisms of 4 or 6 sides modified by smaller planes. It is attacked by nitric acid, yielding a yellow metallic residuum. When fused by the blowpipe, the tellurium is volatilized, and a small globule of a pale yellow color remains which is a mixture of gold and silver.

Telluric silver (white tellurium). This substance is malleable, of a lead grey color, and contains both gold and silver; of the former 26 per cent.; these two metals are combined with lead as well as tellurium. It occurs in large grains in the Altaï mountains.

Seleniuret of silver and copper (eukairite). A soft, sectile, metalloid substance, in appearance similar to galena; fusible by the blowpipe, affording a non-malleable metallic grain; it is attacked by nitric acid; the solution deposits copper and silver on a piece of iron. It contains 30 per cent. of silver; is disseminated in calcareous and magnesian rocks.

Ioduret of silver. A soft substance of lamellar tex-

ture, white externally and yellow internally; has been found associated with native silver in a calcareous gangue in the Temeroso mountain, State of Zacatecas, Mexico.

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THE ASSAYING OF SILVER ORES.

Silver dissolved in nitric acid, is precipitated from the solution by hydro-chloric acid and common salt in the form of a white curd, which is chloride of silver, soluble in ammonia, and assumes a violet color when exposed to the light. It is precipitated from its nitric solution by copper, in slender crystals which yield a bead of pure silver, when submitted to cupellation with half their weight of lead.

The estimation of metallic silver is effected by the dry way and by the wet way, when in the form of chloride of silver, which is heated to the boiling point, having been previously well washed.

Without entering into all the details of the different methods of analyzing argentiferous substances, we will state that, in general, they are treated with nitric acid, and the silver is precipitated by hydro-chloric acid; or they may be treated with aqua regia, and in that case the chloride of silver remains in the residuum; or the substance is submitted to cupellation, with a due proportion of lead.

When the chloride of silver is obtained, it is dried on blotting paper and weighed, the quantity of silver may then be easily estimated knowing that the chloride contains:

Chlorine....	24,67
Silver	75,33
	100,00

IRON.

Iron occurs in nature in different forms:

1st. Native iron; 2d. Oxide of iron; 3d. Salts of iron;

4th. associated with combustible bodies, principally with sulphur and carbon.

NATIVE IRON is of a whitish-grey color, ductile, malleable, and the toughest of all metals; it is always attractable by the magnet; the crystals are sometimes octahedrons, but most generally they occur in a branch-like form.

When pure, it melts with great difficulty; but it has the valuable property of softening at a low temperature, and is then easily fashioned with the hammer. It is attacked by nitric acid, evolving nitrous gas. It does not scratch glass. It is found in a great number of mines, and in volcanic products.

ANHYDROUS PEROXYDE OF IRON is very abundant in nature, and occurs in the four following states:

1st. *Red ironstone* (specular iron). The crystals are acute rhombohedrons; some are thin hexagonal tables with oblique edges; they are of a dark steel-grey, and splendent metallic lustre, and the surface is often iridescent; when pulverized, the powder is dark cherry red.

2d. *Micaceous iron*, the same as the red ironstone, in thin scales; it is found scattered through some quartz oze rocks, having the appearance of plumbago.

3d. *Red Hœmatite* occurs in large nodules and stalactitic forms, with a fine radiated structure; the fibres are sometimes above a foot in length; it is always opaque, of a deep red, inclining to iron-grey, frequently intermixed with oxide of manganese; it is then dark brown red.

4th. *Red ironstone* is compact, without metallic lustre: the fracture is often fibrous; sometimes granular, or of a dull earthy aspect. When pulverized, the powder is red. Pure anhydrous peroxyde of iron contains 69,34 per cent. of metallic iron.

HYDRATE OF PEROXIDE OF IRON (brown iron ore). This ore is more abundant than the anhydrous peroxide; it is of a dark coffee-brown, but when powdered, is yellow. When pure, it consists of 85,3 of peroxyde, or 59,15 per

cent. of metallic iron and 14,7 of water, which latter it loses by calcination, and then it becomes red. The principal varieties are brown hœmatite, occurring in large nodules; it has a fibrous brown-colored fracture, and often black from the admixture of earthy hydrate of peroxide of manganese.

Brown ironstone is compact, sometimes mixed with clay. This is a good quality of ore. The ores of granular hydrate of peroxyde of iron are divided into:

1st. *Oolitic ore*, belonging to the oolitic formation, where it is found in layers, consisting of small granules aggregated by calcareous or ferruginous cement; it is an inferior ore, yielding iron of a bad quality, on account of the phosphoric acid which it usually contains;

2d. *Granular ore.* The granules vary in size; they are sometimes agglutinated by a cement of nearly the same composition as itself, but more frequently encased in clay. It is of a good quality, and generally occurs in tertiary formations.

Argilaceous substances that contain too small a proportion of the above peroxide of iron to constitute a true ore, receive the name of red and yellow ochre.

Magnetic iron ore (loadstone, oxydulous iron) is often found in immense beds, and even constitutes mountains, as at Taberg and Dannemora, in Norway and Sweden, and at Gellirard, in Lapland. It occurs also in the United States and in other countries. It has a dark iron-grey color and metallic lustre. It resembles specular iron; but they are distinguished by pulverizing them; the powder of the specular iron is red, that of the magnetic iron black. It is always strongly attracted by the magnet, a circumstance which sometimes occurs with the specular ore; but those specimens which exhibit polarity are themselves natural magnets. When pure, it contains 71,8 per cent. of metal. It frequently contains titanium.

Carbonate of iron. There are two varieties of carbonates; iron spar or spathic iron (siderose), and lithoid or clay iron ore.

Spathic iron occurs only in transition and primitive formations; when pure it is of a yellowish grey, resembling calcspar in appearance; but when a commencement of decomposition has taken place, it assumes a rust color. It crystallizes in rhombohedral plates, and is usually associated with a certain proportion of carbonate of manganese or magnesia, and even carbonate of lime. When it contains from 3 to 3,8 per cent. of metallic iron, it is not easily dissolved in acids. Decomposition takes place when it is exposed to the air, and even in the thickness of the veins; it first becomes brown, and finally is converted into a mixture of peroxide and hydrate of peroxide, without changing its form. Spathic iron ores, in the last stage of their spontaneous decomposition, are considered very valuable from their richness and superior quality.

Clay iron ore. This ore is generally found in the coal districts; it occurs in flattened nodules, with an intermixture of clay and silica, oxide of iron and the carbonates of lime, magnesia and manganese, but in smaller proportions than in the spathic iron. It is thoroughly penetrated with bitumen, and even coal, and almost always contains a certain quantity of phosphate of lime or iron; it is sometimes mixed with iron pyrites, galena and blend. This mineral is very extensively used in England.

Iron pyrites are sulphides of iron, (a combination of sulphur and iron in variable proportions). There are three species, two of which, *common* and *white iron pyrites*, differ in crystallization, but consist of the same elements and in the same proportions.

1st. *Common pyrites* (mundic of the miners) is a yellow metallic substance; crystallizes in cubes, octahedrons and in forms of the pentagonal dodecahedrons. When heated it emits sulphureous vapors; it is not attacked by the acids. It is used for the production of sulphuric acid, alum and sulphate of iron or copperas. Iron pyrites is one of the most abundant ores in nature, and more universally distributed, perhaps, than any other mineral,

being found in every kind of rock that we are acquainted with. In some localities it contains particles of gold, as at Beresoff, in Siberia, and Macugnaga, in Italy.

2d. *White iron pyrites* is of a much paler color than common pyrites, and although of the same composition, differs from it in the form of its crystals, which are thin tables derived from a rhombic prism, with sharp or acute edges: from its peculiar forms it has been called cocks-comb pyrites and spear pyrites.

The radiated nodules, so common in chalk cliffs, are of this kind: their exterior is often of a brown color, and without any metallic lustre; this is the result of decomposition, by which it is converted into hydrous oxide of iron. Both kinds are found in coal.

3d. *Magnetic pyrites* is of a darker color, inclining to that of bronze, and is much softer than the other species. When crystallized it assumes the form of the hexagonal prism. It is not so plentiful as the two preceding ones. It is a mixture of bisulphide and proto-sulphide of iron.

Phosphate of iron (vivianite). When crystallized it is perfectly transparent, vitreous, or somewhat pearly, and of a deep blue color. It sometimes forms radiated nodules, and occurs also in opaque earthy masses resembling lumps of common indigo. It consists of phosphoric acid 31,18, protoxide of iron 41,23, and water 27,49. When pulverized it may be fused into a scoria attractable by the magnet.

Arsenical pyrites (mispikel), is nearly as white as silver. Fused by the blowpipe it emits thick fumes of arsenic, of which it contains above 40 per cent., and leaves a button which has the appearance of magnetic pyrites.

Arseniates of iron are scarce; their crystals are generally green, sometimes blue as in skorodite. It is sometimes found with brown hœmatite and copper ores.

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THE ASSAYING OF IRON ORES.

BY THE DRY WAY.

An expeditious method of ascertaining the quantity of iron contained in a mineral, consists in melting it in a crucible, after being pulverized, with a mixture of:

Silica	30
Alumina	20
Lime	50

When the crucible is removed from the fire, it is allowed to cool and then broken; the scoria is also broken, and the granules of iron separated with a magnet.

If the scoria is green, it indicates the presence of protoxide of iron, and that the operation has failed; it should be recommenced, the temperature raised and the quantity of flux increased.

THE ASSAYING OF IRON PYRITES.

We will assume that the only metals contained in the ore are iron and copper, the gangue being quartzose and calcareous.

Dissolve at a moderate heat about one-sixteenth of an ounce of the ore in hydro-chloric acid, to which have been added a few drops of nitric acid; filter the solution: the insoluble residuum is the sulphur and quartz.

The lime, iron and copper remain in the solution, from which the excess of nitric acid is expelled by heating; then pass through it a current of sulphuretted hydrogen; after twenty-four hours filter, and wash the residuum on the filter, dry it and collect it; burn the filter and place the ashes with the sulphide of copper on a moderate fire in a porcelain crucible, after adding a little flower of sulphur. Care should be taken to protect the mixture from the contact of air.

To separate the iron, add ammonia to the filtered solution, from which the copper has been precipitated, pass a second current of sulphuretted hydrogen through the liquor; iron will then be precipitated. Collect the pre-

cipitate on a filter, wash it with moderately diluted hydro-chloric acid, which will dissolve the sulphide of iron. A few drops of nitric acid will peroxidize the iron; warm the liquor, then add ammonia, a gelatinous red precipitate will be obtained; heat it again for about twenty-four hours, then pour out the liquor and add distilled water, and heat again for a few hours. Filter the liquor, wash the residuum with warm water; dry the precipitate which should be heated to a red heat; and the quantity of peroxyde of iron is obtained by ascertaining the increased weight of the capsule, in which it is contained. The iron is determined by calculating the 70 of 100 of the weight of the peroxide.

This is a very long process, and yet it applies only to a very simple pyrites, for, in addition to iron and copper, it may contain lead, zinc, gold and silver, the separation of which is a long and difficult operation. Our space will not allow entering into fuller details in this respect.

If it is required to know whether a substance contains iron only, reduce it to a powder and treat it with sulphuric acid. Add chlorine to the solution, and the presence of iron will be detected if a black precipitate is formed by the addition of the tincture of galls, and a blue precipitate with the hydro-cyanates of potassa and soda, and if the sulphate affords a white precipitate with the alkalies, turning to blue by contact with air.

We will finally observe that the sulpho-cyanide of potassa imparts to a solution containing traces of iron, a pink color, which becomes red when the proportion of iron is considerable.

ANTIMONY.

Pure antimony is of a bluish silver-white color; lamellar fracture; is so brittle that it is easily pulverized in a mortar; melts at a dull red heat, emitting thick white fumes. Fuses by the blowpipe, giving off white fumes, and deposits on the charcoal a ring of thin crystals of oxide of antimony. If the button, while in a

state of fusion, is let fall on a sheet of paper, it separates into a multitude of smaller globules which remain a long time incandescent, and move swiftly in all directions on the paper, leaving white tracks of oxide of antimony. With borax or other vitreous fluxes, oxide of antimony formes glass of a yellowish color. In a solution of antimony, water occasions a white precipitate; this does not occur with an organic acid.

Sulphuretted hydrogen causes a yellowish red precipitate; hydro-sulphate of ammonia also affords a precipitate which is redissolved in excess of the reagent; hydro-chloric acid determines a precipitate in the latter solution. Antimony is precipitated from its solutions by tin, zinc and iron.

Antimony occurs in nature in the following forms:

NATIVE ANTIMONY. Distinguished by its metallic lustre, tin-white color, lamellar texture, brittleness and softness. It dissolves in nitric acid and deposits a whitish substance. When thrown on red hot coals, it emits white fumes. It is found, in very small quantity, in veins, in various parts of the globe.

SULPHURET OF ANTIMONY (grey antimony). This mineral occurs either massive or crystallized in six-sided prisms, the crystals being aggregated in divergent groups; they are sometimes several inches in length and very often capillary, intersecting each other in all directions: a variety called plumose resembles felt, consisting of delicate fibres interlaced. The surface of the crystals is sometimes furnished with brilliant prismatic colors. It is usually of a lead-grey color and metallic lustre. It is so soft that it yields easily to the pressure of the nail. When pulverzied, the sulphuret is of a greyish-black. It contains about 72,86 antimony and 27,14 sulphur. Sulphuret of antimony is usually associated with quartz, sulphate of baryta and carbonate of lime, and is sometimes found in numerous fissures in micaceous schist. It is attacked by nitric acid and leaves a white precipitate; soluble in hydro-chloric acid, from which it may be separated by water, and from

which it is precipitated of a yellow color, by the hydro-sulphates. Fusible in the flame of a candle, and when exposed to the blowpipe it is entirely volatilized into white fumes. Antimony is applied to many purposes; it is used in the composition of *type metal*, for which it is alloyed with lead; and in forming *Pewter and Brittannia metal* it is combined with tin.

SULPHURET OF ANTIMONY AND LEAD. A steel-grey substance, crystallizing in hexagonal prisms. Fusible by the blowpipe, with evolution of white fumes and a deposit of yellow oxide on the coal.

SULPHURET OF ANTIMONY AND IRON. This proto-sulphide of antimony and iron has a metallic lustre and iron-grey color. It crystallizes in rhombic prisms, but occurs more commonly in lamellar masses. It fuses easily in the flame of the blowpipe, emitting white fumes, and leaving black globules, attractable by the magnet.

SULHPURET OF ANTIMONY, LEAD AND COPPER. Is of a lead-grey color; crystallizes in rectangular prisms; fusible by the blowpipe, emitting antimonial vapors, and yielding yellow oxide of lead, and finally a button of copper, soluble in nitric acid, with a precipitate, and metallic lead on a piece of zinc immersed in the solution; and by addition of ammonia the presence of copper will be manifested by coloring it an intense blue. This mineral generally occurs in lead and copper ores.

CUPREOUS SULPHURET OF ANTIMONY. A substance little known and very rare; of a lead grey color; conchoidal fracture; when pulverized its powder is black; crystallizes in rhombic prisms.

SULPHURET OF ANTIMONY AND LEAD. Is of a steel-grey color, and crystallizes in rhombic prisms; it is attacked by nitric acid producing a white precipitate containing antimony; is found in Cornwall and Hungary.

WHITE OXIDE OF ANTIMONY (white antimony). A white substance of a pearly lustre, soft and fragile; fusible in the flame of a candle; when heated in a glass tube or on coals, it is entirely volatilized, if pure, into a

white vapor. Found in small quantity with ores of antimony.

Earthy white antimony. The same as white oxide of antimony, combined with water, the proportion of which has not yet been ascertained. It occurs in the form of a powder, coating the surface of the grey antimony ore.

Red antimony ore (kermes). A compound of the oxide and sulphuret of antimony, of a dull red color. It crystallizes in tufts of delicate crystals radiating or interlaced, and as fine as hairs. Heated in the flame of the blowpipe it fuses and emits antimonial vapors; heated in a matras it yields oxide of antimony. It is a rare substance, found occasionally on the surface of grey antimony ore, and among the ores of arsenic; but which, *if found abundantly*, would prove a profitable mineral.

Sulphuret of antimony with nickel. A mineral of a steel-grey color; crystallizes in the cubic system. Fusible by the blowpipe, emitting antimonial fumes. Attacked by nitric acid, giving a precipitate; the solution is of a greenish color which becomes violet by ammonia in excess, and gives a green precipitate by the alkalies. It frequently contains arsenic. This mineral is rarely found crystallized, but occurs generally in small compact masses of a lamellar texture; it is met with in ores of cobalt.

Arsenical antimony. A rare mineral of a steel-grey color; when roasted it emits white fumes without a residuum. Attacked by nitric acid, affording a white precipitate; soluble in hydro-chloric acid, from which it may be separated by addition of water. It is a compound of arsenic and antimony of variable proportions, which have not yet been accurately determined. It occurs in the Dauphiné and the Hartz.

THE ASSAYING OF THE ORES OF ANTIMONY.

BY THE WET WAY.

We shall apply this process to the assay of the sul-

phuret of antimony only, being the most abundant, and that which is the most frequently worked. When treated with aqua regia, the ores of this sulphuret afford a residuum composed of sulphur and gangue. After washing and drying it, weigh it, and burn out the sulphur, the weight of which is determined by the loss. The acid solution contains the antimony, which precipitates from it in the form of a chloride by addition of water, then saturate the liquor with carbonate of potassa; another precipitate will be obtained. After slightly acidulating the liquor, add nitrate of baryta, and separate the sulphate of baryta, whereby the quantity of sulphur is deduced. Dissolve the oxi-chloride which was precipitated by water, in hydro-chloric acid, and decompose it by immersing in the solution a slip of zinc, the metallic antimony will thus be obtained. The precipitate formed by the carbonate of potassa may contain iron, copper, lead and antimony. It should be treated with nitric acid which dissolves them all, except the antimony. By adding sulphuric acid to the solution, sulphate of lead is precipitated; and sulphide of copper, by adding sulphureted hydrogen; finally the iron is separated by ammonia in excess.

It is always advisable, before analyzing the sulphuret of antimony to treat it with weak hydro-chloric acid, to dissolve the carbonate of lime which constitutes the gangue.

As the composition of the sulphuret of antimony is invariable (antimony 72.78; sulphur 27.22), the following process may always be used: Boil the ore in concentrated hydro-chloric acid, which dissolves only the sulphide of antimony, then precipitate it, in the form of oxi-chloride, by water.

BY THE DRY WAY.

To assay an oxidized mineral, take from one fourth of an ounce to an ounce of the ore, according to the quantity of antimony it may contain, mix it with its weight of carbonate of soda and about a fourth of an ounce of

charcoal ; heat the mixture in a crucible to a red heat, for 15 to 20 minutes. When it has cooled, break the crucible, and after cleaning the button thus obtained by brushing it, weigh it, the quantity of antimony contained in the ore will thus be ascertained.

The loss by volatilization is sometimes considerable, and always in proportion to the time the operation has lasted. To reduce sulphurets, recourse is had to the combined action of about one fourth of an ounce of charcoal and a slip of iron, the quantity of ore operated upon being half an ounce.

MERCURY.

Mercury is the only metal that remains liquid at ordinary temperatures. Its density is 13.59 ; to become solid it must be exposed to 390 of cold below zero of Fahrenheit, it is then malleable. Metallic mercury is freed from its salts by lime, potassa and soda, under the influence of a red heat. A piece of copper immersed in an acid salt of mercury is coated with the metal, but disappears on the application of heat, by which it is volatilized.

Mercury occurs in nature, 1st as native mercury; 2d as a sulphuret; 3d as an amalgam or in combination with silver; 4th as a chloruret ; 5th as a seleniuret of mercury; 6th as an ioduret of mercury. The ores of mercury which occur the most generally are the sulphuret or cinnabar, the seleniuret and the chloruret. The gangue in which it is encased, is usually bituminous schist.

1st. Native mercury. Globules of this metal are often met with in masses, of cinnabar, in pyrites and in cavities of the veins. It is then nearly pure. It is found near Idria, dispersed through a blackish argilaceous schist in compact calcareous rock.

2d. Cinnabar, a sulphuret of mercury which occurs in various states, and is the most abundant of quicksilver ores. It is sometimes found in six-sided crystals, transparent, brilliant and of a fine carmine color ; some-

times in masses of a granular structure, the color inclining to steel-grey; of a metallic lustre; and also as a fine powder of a deep scarlet color, which is commonly called vermilion, and is contained in the cavities of massive cinnabar. There is likewise an impure variety (hœpatic ore,) with a slaty structure, of a dark liver-red or blackish color which contains carbon and bitumen.

Cinnabar is soft and fragile, its fracture lamellar in one direction and granular in the others. Its specific gravity, when pure, is 8. When heated in the flame of the blowpipe the sulphur burns with a pale blue flame and sulphureous smell and the whole mercury will be volatilized; and if a piece of clean copper be held over the vapor of the cinnabar, it will be coated with mercury. Heated in a closed tube with soda it does not volatilize but yields globules of metallic mercury. It is attacked by aqua regia; a slip of iron will precipitate a grey powder from the solution.

3d. NATIVE AMALGAM (argentiferous mercury). This mineral resembles silver, crystallizing in some of the same forms. When heated in a tube, mercury is distilled from the ore, leaving a button of malleable silver. It is found in cinnabar, but is a rare substance.

HORN MERCURY (chloruret of mercury). This is the same substance as *calomel*, and occurs in small quantity in some quicksilver mines in the Palatinate, Carniola and Spain. It is found in small mammellated masses, or modified square transparent prisms, with an adamantine lustre. It is soft and waxy in its texture. It is easily volatilized by the blowpipe.

SELENIURET OF MERCURY. A substance of a greyish copper color and metallic lustre, and volatile. It is a compound of one atom of selenium and four atoms of mercury. It occurs abundantly in Mexico, but is rarely met with in other parts of the world.

IODIDE OF MERCURY. Of a brown-red color; has been found in one locality only in Mexico.

THE ASSAYING OF QUICKSILVER ORES.

BY THE DRY WAY.

Use a long necked glass well luted; adapt to the neck by means of a luted cork, a tube, the extremity of which is immersed in a vessel containing water. Pulverize the ore and place it in the retort with caustic lime; according to the richness of the ore, make a mixture of one-fourth to half an ounce of the latter and half to two ounces of lime. Maintain a red heat under the retort for 25 or 30 minutes, until the glass begins to soften. Break the neck of the retort by letting a drop of water fall on it while hot, and collect the mercury which has condensed in the water. Wash it with diluted hydro-chloric acid; then dry it in a porcelain capsule and weigh it.

BY THE WET WAY.

Pulverize the ore, and dissolve it in nitric acid; add proto-chloride of tin and hydro-chloric acid and boil. A greyish precipitate will be obtained, which will soon assume the form of liquid mercury. By this very simple process, the mercury may be separated from all the substances with which it is usually found. If other metals should occur, they may be separated by distillation.

TIN.

A silver-white metal, when it has not been tarnished by exposure to air. In nature it is never found in the metallic state. It is always combined with either sulphur or oxygen.

Sulphuret of tin. A rare mineral which has been found, hitherto, only in Cornwall. It is metallic, of a yellowish-grey color inclining to red, and consists of sulphur 30,5, copper 30, tin 20,5 and iron 12. Fusible by the blowpipe; soluble in nitric acid with precipitate. Copper is precipitated from the solution by a piece of iron immersed in it; and becomes blue by addition of

ammonia, precipitating at the same time oxide of iron.

Oxide of tin (tinstone). The oxide of tin is its chief ore, and the one from which all the tin used in the arts and manufactures is obtained.

When pure, it is colorless; but it is much oftener brown, sometimes black from the oxide of iron it generally contains. The crystals are derived from a square prism. In hardness it is always equal to quartz, scratching glass and felspar.

Tinstone is sometimes massive and granular: in the latter case, it is much intermixed with quartz, which is the usual vein-stone of tin ore.

Tinstone is found in many parts of the globe; but there are few in which it exists in great quantity. The Cornish mines are by far the most productive in Europe, affording probably three times as much as all the others. Next to Cornwall, the greatest quantity of tin is obtained from the mines of Malacca and the island of Banda, and in Europe, principally in Bohemia and Saxony. Oxide of tin ore is fusible by the blowpipe, and not readily attacked by hydro-chloric acid. Its solution in this acid affords a purple precipitate with chloride of gold. Oxide of tin is precipitated by nitric acid, and the precipitate passes easily through a filter.

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THE ASSAYING OF TIN ORES.

Three methods are used in the assaying of these ores which are invariably intermixed with various substances: washing, the dry way and the wet way. Washing is the method employed in the mines; it serves to show whether the ore is worth working. The assay by the dry way is more accurate; but that by the wet way is preferable to either, as being more perfect.

1st. — By washing.

This process is based on the density of tin, which is 6,9, whereas that of the rock, which encases it, is only about 2,6.

Roast the ore, then pulverize and mix it with a little water, and wash in a pan, as would be done for gold. A residuum is thus obtained of yellow or brown oxide of tin, intermixed with arsenical iron, which the eye can easily distinguish.

2d. — By the dry way.

This assay may be effected at a low temperature. Put the ore into a stone crucible with equal parts of a mixture of carbonate of soda and borax; leave the crucible uncovered; keep the mixture in a state of fusion for 20 or 25 minutes; let the crucible cool, then break it; the button obtained almost always contains iron derived from the ore. Then treat the button with nitric acid, which will dissolve the iron, and the tin will remain in the liquor, insoluble.

Heat the liquor for some time at a moderate temperature, and filter; wash it carefully, then collect the residuum on the filter separately; the united weights of the two will give the quantity of oxide of tin.

3d. — By the wet way.

Mix twenty grains of pulverized ore with about one-fourth of an ounce of caustic potash; heat the mixture in a silver crucible; then dissolve the mass in hydrochloric acid in excess; treat the portion which does not dissolve, with caustic potash heated to redness, it will then easily dissolve in the water and acid. Evaporate the solution slowly until it acquires a gelatinous consistency, add water and filter the solution; the silica will be retained on the filter. The tin, lead and copper will be precipitated by immersing a piece of zinc in the liquor. These metals may then be separated by the processes described elsewhere.

When it is desired to determine the quantity of tin by the wet way, all the soluble substances may be got rid of by aqua regia, the residuum will then comprise only the oxide of tin and some silicates. This residuum should be well pulverized and treated with aqua regia, and al-

lowed to boil for some time; the copper and arsenical pyrites are dissolved, whereas the oxide of tin is not attacked; treat the oxide of tin with potassa, then with water and hydro-chloric acid; finally pure tin will be precipitated from the solution by a piece of zinc.

ARSENIC.

Arsenic is a solid substance, of a steel-grey color, fragile, very brilliant, but loses its brilliancy by contact with moist air. Its crystals are sometimes granular, sometimes lamellar. Insoluble in water; when oxidized it becomes soluble and a violent poison. Specific gravity 5,75. When heated in a close vessel, it sublimates without fusing, and its vapors condense on the sides of the vessel in the form of crystals. It crystallizes in tetrahedrons. It can be fused only under a pressure superior to that of the atmosphere. In nature it occurs in various forms.

Native arsenic. A substance of a metallic lustre, which soon blackens when exposed to the air. It differs from that which is obtained from arsenical mines only by its smaller density. It is frequently intermixed with arseniurets and sulphurets of antimony, cobalt and silver. These ores are usually found in granitic rocks; sometimes in schist and mica-schist, and sometimes in cupreous schist.

Red sulphuret of arsenic (realgar). A red substance of pearly lustre; crystallizes in oblique rhombic prisms, acquiring resinous electricity by friction; emits a strong smell of garlic in the flame of the blowpipe; more fusible than arsenic and orpiment; burns with a blue flame; when heated in a closed tube, it fuses and volatilizes, and the vapors condense in crystals in the upper end of the tube. It is found more generally in metallic veins, in certain volcanic products, and sometimes disseminated in the various rocks.

Yellow sulphuret of arsenic (orpiment). This min-

eral is usually of a yellow, pearly lustre, and occurs in soft, flexible and semi-transparent plates, crystallizing in oblique rhombic prisms. More easily fused than arsenic, it burns in the flame of the blowpipe, emitting fumes with the odor of garlic; fusible and volatile when heated in a closed tube, and deposits yellow crystals in the upper end; acquires resinous electricity by friction. This sulphuret is less abundant than the preceding one. It occurs sometimes in the interior of metallic veins, and also in productions of a volcanic nature.

Arsenious acid. A soft, white substance, crystallizing in regular octahedrons, slightly soluble in water. Nitrate of silver produces a red precipitate in its solution. When heated in a tube it is volatilized without fusing, and leaves no residuum; emits a smell of garlic when heated with charcoal dust, or in the reducing flame. This mineral is seldom found crystallized in nature; it most commonly occurs in small compact masses, or in pulverulent deposits.

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THE ASSAYING OF ARSENIC ORES.

Each variety of the ores of arsenic requires a different process and special apparatus. We shall not enter into the details of these operations; suffice it to say, that the presence of arsenic is easily detected, by throwing a small quantity of pulverized ore on hot coals; white fumes are instantly emitted leaving a strong smell of garlic. A nitric solution of arsenical ore yields a precipitate of a beautiful yellow color by addition of hydrosulphuric acid.

GOLD.

Gold is the most malleable of all metals. Density 19,26. When reduced into thin leaves it becomes transparent, and when held to the light exhibits an intense bluish green color. When pulverized, the

powder has a purple color; crystallizes in quadrangular prisms. Gold is volatilized by the heat of the oxi-hydrogen blowpipe. Acids have no action on gold, even when concentrated. It dissolves in chlorine; and it is by the chlorine which is generated in a mixture of one part nitric acid and four parts hydro-chloric acid, that it is dissolved. It most usually occurs in nature in the native state, and is often found associated with other minerals.

NATIVE GOLD crystallizes in the cubic system. Fusible by the blowpipe, soluble in chloro-nitric acid or aqua regia. This solution yields a purple precipitate by addition of chloride of tin. Density varies from 12,66 to 14,70. Harder than tin and lead, but softer than iron, platinum, copper and silver. Gold is never found in nature entirely pure; it is frequently alloyed with copper and silver.

ELECTRUM is the name applied to a native alloy of 64 parts of gold with 36 of silver. It is met with generally in veins in Siberia, Hungary and Transylvania, but not often in sand or grains.

A variety occurs in Brazil containing 86 parts gold, 4 of silver and 9 of palladium. Gold is also found associated or combined with other metals.

THE ASSAYING OF GOLD ORES.

BY THE WET WAY.

Treat the powdered ore with chloro-nitric acid (aqua regia) to dissolve the gold and separate it from the gangue, and precipitate it from the solution by sulphate of protoxide of iron. Wash the precipitate repeatedly with water acidulated with hydro-chloric acid, and the gold thus obtained will be perfectly pure. If to the chloro-nitric solution nitrate of protoxide of mercury is added, the gold will likewise be precipitated, and pure metallic gold will be obtained by heating this precipitate to redness in a porcelain crucible.

The gold may also be precipitated from its solution by

addition of sulphureted hydrogen, and heating the sulphuret thus formed to a dull red.

Finally, chloride of antimony also precipitates gold in the metallic state from the chloro-nitric solution.

BY AMALGAMATION.

Gold easily amalgamates with mercury; the ore being pulverized is placed in a pan with mercury and water; after stirring for some time, the gold separates from the substances in which it was contained, and combines with the mercury. Heat hastens the formation of the amalgam. Mercury can dissolve a considerable quantity of gold, without ceasing to be liquid. When mercury is saturated with gold, the amalgam is soft, and can be worked as easily as wax. When the liquid amalgam is obtained through a piece of wash leather by wringing, a residuum is left of two parts of gold and one of mercury; by heating the residuum, the mercury is volatilized, leaving the gold in a solid metallic state.

ZINC.

Zinc is never found in the metallic state, but occurs as an oxide, a sulphuret and as salts of zinc. Metallic zinc is a produce of the metallurgic art. Density 7,10; volatile at a higher temperature; it is slightly oxidized when exposed to damp air. When melted in contact with air, its surface is oxidized, and when it begins to be red-hot, it burns with a brilliant phosphorescent light, and is dissipated in the form of white flakes of oxide of zinc. When brought into contact with copper, it strongly develops electric fluid; it almost always forms the negative pole in a galvanic battery. In nature, it occurs in the following states:

Sulphuret of zinc (blende, black jack). When pure it is of a yellow color, slightly tinged with green; but is much oftener dark reddish-brown, or garnet-red, and contains some portion of sulphuret of iron. It crystallizes in the form of the rhomboidal dodecahedron. Infu-

sible by the blowpipe and not reducible. Blende contains from 50 to 60 per cent. of zinc, the remainder being sulphuret of iron. Specific gravity 4,16. Some varieties become phosphorescent by slight friction. Blende is found principally in the same localities as galena, and often intermixed in the same vein. It is found also in granitic rocks and gypsum.

Oxi-sulphuret of zinc. Opaque, of a dull rose or yellow color, streaked with brown stripes, of a pearly lustre in the direction of the layers, but vitreous or resinous in the other directions. Attacked by hydro-chloric acid, with evolution of sulphureted hydrogen.

Red zinc ore. This mineral contains binoxide of manganese; it is of a red, brownish or blackish color, with a coarsely lamellar texture; crystallizes in rhombic prisms. Is found in several iron mines in the United States.

Carbonate of zinc (calamine). Is abundant in many of the localities of lead ores. Crystallizes in the rhombohedral system. It dissolves in nitric acid with effervescence; ammonia produces in the solution a white precipitate, which is redissolved in excess.

Oxide of zinc. A yellowish or whitish substance; crystallizes in rhombic prisms. Infusible by the blowpipe; soluble in acids to a gelatinous consistency. Occurs in certain deposits of copper and lead.

Anhydrous silicate of zinc. This is a compound of zinc, iron, silica and aluminium. Has a vitreous or glassy lustre, sometimes white, sometimes yellow, reddish-brown or ash-grey; it derives these various colors from a small quantity of oxide of manganese or iron. Crystallizes in regular octahedrons or prisms.

Sulphate of zinc (white vitriol, white copperas). A white substance; crystallizes in rhombic prisms. Its taste is nauseous and very styptic. Soluble in water; if a small quantity of ammonia or potash be added, a white gelatinous precipitate takes place it redissolves in excess of the alkalies. This substance is produced by

the decomposition of blende in mines which have been abandoned.

THE ASSAYING OF ZINC ORES.

BY THE DRY WAY.

Mix the ore with 15 or 20 per cent. of charcoal, and heat to whiteness in a crucible.

When the zinc ceases to emit fumes, remove the crucible from the fire; pulverize and roast the charcoal which remains, if necessary. The quantity of zinc will be obtained by ascertaining the loss undergone by the substance experimented upon, assuming that the latter was perfectly dessicated before being introduced into the crucible.

The results obtained by this process, as by all those by the dry way, are inaccurate; it is therefore preferable to determine the metal by the wet way.

BY THE WET WAY.

Two methods are in use, one for the assaying of blende, and the other for that of calamine.

ASSAY OF CALAMINE. Roast and pulverize the ore, dissolve in hydro-chloric acid in excess, evaporate to dryness; treat with water and filter. To the filtered liquor add ammonia in excess, separate the precipitate; the solution contains oxide of zinc, and sometimes oxide of copper. To separate the latter, have recourse to the ordinary process for copper ores.

ASSAY OF BLENDE. Treat one part of pulverized blende with three or four parts of nitric acid at a gentle heat. Pour off the solution, and boil the residuum with one part of aqua regia. Filter the solution; the acid liquor contains the zinc, some copper, sulphuric acid, etc.; to which add chloride of baryum, and proceed as for calamine.

LEAD.

The density of lead is 11,55 ; is volatilized at a red heat. It combines with oxigen and forms several oxides, the protoxide, the binoxide of lead or plumbic acid. The most abundant ore of lead is the sulphuret or galena : this, however, is never pure ; it almost always contains silver, which may be detected by the dry process.

It is frequently associated with other sulphurets, such as blende, iron pyrites, grey copper, sulphate of baryta, etc.

Salts of lead are characterized by the formation, in a warm solution gradually diluted with cold water, of a precipitate, by addition of sulphureted hydrogen.

The combinations of lead which occur the most commonly in nature, are the following :

Native lead. A substance of rare occurrence. It has been found in small grains or laminæ, and in specimens of galena. It has a grey color ; is very ductile and malleable ; when fusible by the blowpipe, it leaves on the charcoal yellow oxide of lead ; attacked by nitric acid, evolving nitrous gas. A precipitate is formed in a solution by addition of a sulphate ; metallic lead is deposited on a piece of copper dipped in the solution.

Sulphuret of lead (galena). This substance is easily recognized by its crystallizations of a pure lead-grey color. The crystals are either cubes or octahedrons, and sometimes cubes with the edges replaced. Their surface is often dull, but that of the fracture is always brilliant. Fusible by the blowpipe, giving off sulphureous fumes. Soluble in nitric acid, the solution throwing down a white precipitate of sulphate of lead on a piece of zinc. Galena is one of the most abundant metallic ores in nature ; it is found in almost every formation, both in the oldest and in the jurassic, and occurs in large quantity in certain granites and argilaceous schistes. Galena usually contains more or less silver ; when pure it contains 86 per cent. of lead. Seleniuret of lead or clausthalite is very much like galena, and can be distinguished from it only by an assay.

A sulphuret of lead occurs in Saxony and Lower California, combined with antimony and silver. It has a lead-grey color and brilliant metallic lustre.

Red oxide of lead (minium). A red substance, occurring in the form of powder in some veins of galena and calamine. It is the same substance as the red lead used in painting; but for this and other purposes it is prepared artificially.

Yellow oxide of lead (native litharge). This lead ore, which is less oxydized than the preceding species, occurs sometimes as a powder, sometimes in solid masses, not unlike yellow jasper; its great weight distinguishes it from all minerals which otherwise resemble it.

Carbonate of lead (white lead ore, lead spar). This is the same substance as the white lead of commerce, which is prepared artificially. It fills large veins in some lead mines, or is intermixed with other ores, and is found either compact, earthy or crystalline. It is usually of a white color; but occurs sometimes of a yellowish, brownish or reddish color. Easily reduced by the blowpipe on charcoal. Soluble in nitric acid with effervescence. This is the only mineral which equals the diamond in brilliancy; its lustre, when pure and transparent, being adamantine.

Sulphate of lead (anglesite). A white substance, fragile, of a glassy lustre; crystallizes generally in rectangular octahedrons variously modified. Fusible by the blowpipe into a milk-white bead; reducible on charcoal into a metallic globule, in the reducing flame, and more easily still with the assistance of carbonate of soda. It is easily confounded with white lead. Sulphate of lead was first discovered in Anglesea, in cellular quartz; it is also found in Scotland and Siberia.

Cupreous sulphate of lead of a light blue color has been found in some localities; it is colored by the copper it contains.

Phosphate of lead (pyromorphite). A beautiful mineral which occurs in the lead mines of various countries, though not abundantly. Its color varies from bright

grass-green to yellow, orange, brown, and sometimes a dull violet. It occurs in clusters of hexagonal prisms, occasionally terminated at each end by a low pyramid, as an incrustation, resembling moss. The crystals have generally a greasy lustre, but are sometimes very brilliant, and mostly translucent. Pyromorphyte undergoes a change by fusion, which is peculiar to it: the melted globule, in cooling, becomes angular, and assumes a polyhedral form.

Most specimens contain 9 or 10 per cent. of the chloruret of lead; sometimes arseniate; and those of an orange color, some chromate of lead. It occurs in many lead mines of Europe and the United States.

Arseniate of lead. Of a greenish or blackish color; not easily fused by the blowpipe; reducible on charcoal, giving off alliaceous fumes. Attacked by nitric acid.

Chloruret of lead (ceracite, erroneously, muriate of lead). A scarce mineral first discovered in the Mendip-hills; white or yellowish, nearly opaque and somewhat pearly.

Chloro-carbonate of lead (corneous lead). A transparent mineral, crystallizing in square prisms, with adamantine lustre, which has been found in Great Britain and Germany. Both this and the preceding species are rare; reducible with soda by the blowpipe, into grains of lead.

Chromate of lead (red lead ore). A substance of an orange-lead color, fusible by the blowpipe on charcoal, on which it deposits oxide of lead, and affording grains of metallic lead with carbonate of soda. Attacked by nitric acid from which lead is precipitated by a clean piece of zinc. It is composed of: chromic acid 31,50, oxide of lead 68,50.

There is another chromate of lead, containing oxide of lead 76,36 and chromic acid 23,64. It has a greasy dull lustre, of an orange-red, sometimes compact, more frequently crystallized in rhomboidal prisms. In a mass it is opaque, with transparent edges, soft; and when pulverized, the powder is of a brick-red color; it is dis-

tinguished from the preceding by its deeper color, its duller lustre, its smaller density. It fuses easily by the blowpipe into a brown mass, which assumes a chrystalline structure in cooling. It affords a green glass with borax. It has been found principally in Siberia, associated with read lead, green lead and galena.

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THE ASSAYING OF LEAD ORES.

BY THE DRY WAY.

Most lead ores may be tested by charging a crucible with a mixture of one part of the powdered ore and three or four parts of black flux or a mixture of carbonate of soda and potash, and 20 or 30 per cent. of powdered charcoal. Upon the top of these a heavy layer of common salt must be added to prevent the action of the air, and the whole fused by a gradually increasing temperature. According to the richness of the ore, the quantity operated upon may be from half an ounce to two or three ounces. The button of lead formed in the bottom of the crucible may be taken out by breaking the vessel, cleaned of its enclosing slag, weighed, and the percentage of metal calculated at once. If, in any case, sulphur is supposed to be present, a small quantity of iron (from 5 to ten per cent.) should be added.

The following charge has been found to give the most accurate result: to one-fourth of an ounce of the powdered ore, add from three-fourths of an ounce to one ounce of carbonate of soda, and one-fourth to one-third of an ounce of caustic soda. When the mixture is fused, stir with a piece of iron, which acts as a reagent.

ASSAY OF PLUMBIFEROUS ORES IN THE MUFFLE FURNACE.

The powdered ore is weighed out and placed in the bottom of a crucible of refractory clay. About 60 grains is a charge adapted to a crucible, measuring 4½ inches high and one inch and seven-eigths of an inch greatest interior diameter; when much more is taken, one of larger

dimensions is required. Upon the powdered ore 10 to 30 per cent. of iron is placed, avoiding filings or scraps, as they would adhere to the metallic lead, if they remain undecomposed, and it would be difficult to separate them from it. The quantity of iron added between the above-mentioned extremes must depend upon the amount of sulphur combined with the lead. If pure galena is treated, 22,6 per cent. will exactly enter into combination with all the sulphur; but it is always better to use too much than too little.

Upon the ore and iron throw three times the weight of the ore of black flux, or a mixture of 100 parts potash with 18 of wheat or rye-meal. A spoonful of common salt is placed above these as a protection against the air, and a small piece of charcoal thrown in on the top.

The crucible after being covered is introduced into the furnace and raised by degrees to a strong red heat, at which temperature they should be kept for about half an hour. They may then be removed from the fire, given a slight blow to settle all the metallic particles to the bottom and set aside to cool. Upon breaking the crucible, the lead should be found in the form of a well-defined button attached to the undecomposed iron. A few blows with a hammer directed upon the iron will serve to divide the two, and the lead may be weighed at once.

When a large quantity of the sulphide of iron, zinc or copper is present in the ore, a roasting should be performed previous to the application of the above plan, and a small quantity of glass powder or borax added in the charge.

BY THE WET WAY.

The properties of lead, considered with reference to the assaying of its compounds, are so well defined, that it is unnecessary to describe the details of the processes by which it may be separated from its combinations with other substances; it will suffice to state the following facts:

It is precipitated from its solutions in the form of a black sulphide, by sulphureted hydrogen and the hydrosulphates; these latter in excess do not dissolve the precipitate.

Sulphuric acid and the sulphates form a white precipitate, which is *sulphate of lead.*

Zinc precipitates it in the form of metallic lamellar crystals.

With chlorine it forms a compound almost insoluble in water, and altogether insoluble in alcohol.

Finally, the oxide of lead is insoluble in potash.

In the assay by the wet way, the lead is always determined from the sulphate, which is known to contain 65,32 of pure lead.

MINERS AND PROSPECTORS.

Prospecting is an occupation followed, at the present time, by a great number of persons who, because they have worked in gold, silver or copper mines, think they are competent to discover in what particular spots minerals are to be found. They are *practical miners*, and in the opinion of many, that is sufficient. This prevailing opinion is the cause of numerous disappointments, loss of money and waste of time. It is undoubtedly true that a *practical miner* is more competent than any other man to conduct mining operations, and to tell where may be found a particular kind of ore with which he has become familiar in the course of his mining operations; but it is no reason, because he may have worked seven or eight years in a copper, gold or silver mine, why he should be the most competent person to discover or recognize the various minerals he may come across; more than that is required of him to induce a company composed of intelligent men, to entrust him with such a mission as the exploring and discovering of

mines. The time may not be very far distant when prospecting will no longer be a *trade*, but a *profession*. A *professional prospector* should, therefore, possess some mineralogical knowledge; he must be able to assay the ores on the very spot in those localities which he thinks may contain the object of his research. He must have sufficient geological knowledge to enable him, by mere inspection of a mineral region, to know what minerals it may contain, whereby avoiding great loss of time. We shall not dwell on the physical requisites of a prospector, such as youth, sound health, activity and endurance: he must disregard thirst, hunger and fatigue; and notwithstanding the theoretical and practical knowledge which he must acquire, he should by no means, be a *fine gentleman*. He must handle the pick, if necessary, and *he may be compelled to do so every day*, and in all kinds of weather.

For the present we shall confine our observations to a few general ideas, applicable in the present times.

Miners and prospectors know that minerals possess certain physical properties by which they are enabled to recognize approximatively their nature. The most striking features by which every one may be guided are the only ones that shall now occupy our attention.

The *smell* peculiar to certain minerals deserves notice, for by that alone anexperienced miner may be enabled to recognize the presence of certain metals. The smell of iron, copper and tin is familiar to all, as is also that of a certain number of sulphurets, which is developed by roasting, and the smell of arsenic which resembles that of garlic. Every miner knows that quartz and other minerals emit a peculiar smell when struck with a hard substance. A prospector should be familiar with these various odors.

An other important and very useful character of minerals, is their peculiar *taste*. The sharp taste of some is very different from the astringent taste of alum and hydro-chlorate of lime, and that of the sulphate of iron and sulphate of copper.

The most important character pertaining to minerals is color, upon which we shall dwell more at length.

Color is a very important feature in all minerals, and especially in sulphurets, metallic oxides and native metals. We shall not insist upon the last mentioned minerals, because it is only after considerable labor has been accomplished that they occur; we shall only say that, when pure:

Silver is of a splendent white;
Tin and *mercury*, of nearly the same lustre as silver;
Antimony, of a bluish silver-white;
Arsenic, a greyish white;
Lead and *zinc*, a bluish white;
Gold, pure yellow;
Copper, reddish yellow.

The color peculiar to minerals is the same in the same substances; but if it occurs with the same intensity in bodies reduced to a powder, it does not when the minerals are crystallized; and it frequently happens that if the intensity of the color in a mineral should vary, it becomes a great deal more difficult to determine to what species it belongs. To avoid any mistake, the ore must be pulverized to observe its color, without relying on the general appearance of the mass.

We give below a list of the colors peculiar to the different ores containing the metals of which we have treated in this manual. Although the same color applies to several minerals, yet it is evident that the prospector will know at first sight, by the color of the mineral under inspection, that it belongs to one series of metals; the sphere of his suppositions will therefore be considerably narrowed. From the moment he knows to what minerals the color he is inspecting, belongs, he has only to refer to the mineralogical species which we have described, and he will know with pretty good certainty what species he has in hand. We will observe that the purer and more abundant the ores, the deeper and more characteristic are the colors which belong to them.

WHITE: Chloruret of silver; proto-chloride of mercury (calomel); white arsenic, (arsenious acid; arsenic bloom); sulphate of zinc; carbonate of lead; sulphate of lead.

SILVER-WHITE: Native amalgam.

TIN-WHITE: Native antimony.

PEARL-WHITE: Oxide of antimony; spathic iron (iron spar; carbonate of iron).

YELLOWISH-WHITE: Oxide of antimony.

WHITISH: Ioduret of silver; oxide of tin; oxide of zinc.

BLUE: Hydrous carbonate of copper; arseniate of copper.

BROWN: Sulphuret of silver containing iron; chloruret of silver; hydrous peroxide of iron; hœmatite (iron); oxidized tin (stannic acid).

BROWNISH: Red zinc.

BROWN inclining to YELLOW: Hydrous oxide of iron; sulphuret of zinc (blende).

BLACKISH-BROWN: Anhydrous carbonate of copper.

REDDISH BROWN: Silicate of zinc.

GREY: Native lead.

STEEL-GREY: Sulphuret of copper; grey copper; sulphuret of silver; sulphuret of silver and copper; sulphuret of antimony and lead; sulphuret of antimony with nickel; arseniate of antimony; seleniuret of mercury; arsenic.

LIGHT STEEL-GREY: Tellururet of gold and silver.

IRON-GREY: Sulphuret of antimony and iron; sulphuret of silver; sulphuret of silver with copper and iron (polybasite).

LEAD-GREY: Grey copper; sulphuret of copper with lead and antimony (bournonite); sulphuret of antimony; sulphuret of antimony and iron; sulphuret of antimony and copper; sulphuret of lead.

ASH-GREY: Silicate of zinc; carbonate of silver.
LIGHT-GREY: Phosphate of iron.
WHITE-GREY: Arsenical pyrites (mispikel).
DARK GREY: Carbonate of iron; deuto-sulphide of mercury (cinnabar, vermilion).
DARK GREENISH-GREY: Hydro-silicate of iron.
YELLOWISH-GREY: Oxide of antimony, (tin pyrites).

YELLOW: Gold; iodide of silver; ochre (iron) oxide of lead.
PALE YELLOW: Auriferous silver; electrum, (native alloy of gold and silver).
YELLOWISH: Oxide of tin; oxide of zinc; silicate of zinc; sulphuret of zinc (blende); oxidized sulphuret of zinc.
BRONZE-YELLOW: Variegated copper, (phillipsite); magnesian iron pyrites.
BRASS-YELLOW: Copper pyrites; iron pyrites.
PEARLY-YELLOW: Sulphuret of arsenic.

BLACK: Antimonial sulphuret of silver; seleniuret of silver.
LUSTROUS BLACK: Black oxide of iron; micaceous iron.
BLACKISH: Oxide of copper; red oxide of zinc (spartalite).
VELVET-BLACK: Oxide of copper.
GREENISH BLACK: Phosphate of copper.
GREYISH-BLACK: Magnetic oxide of iron.
RED: Native copper; antimonial sulphuret of silver; arseniate of silver; compact oxide of iron; ochre (iron) ioduret of mercury; manganiferous zinc.

RED-BROWN: Red antimony (kermes).
COCHINEAL-RED: Protoxide of copper; cinnabar.
PEARLY-RED: Sulphuret of arsenic (realgar).
ORANGE-RED: Red lead.
HYACINTHE-RED: Chromate of lead.
DULL-RED: Hœmatite (iron).

DINGY ROSE: Oxide and sulphuret of zinc.

GREEN: Carbonate of copper (malachite).
BLUISH-GREEN: Arseniate of copper, (aphanese).
EMERALD-GREEN: Arseniate of copper, (erinite); arseniate of copper (enchroite).
DARK EMERALD-GREEN: Oxichloruret of copper.
DARK GREEN: Arseniate of iron.
OLIVE-GREEN: Arseniate of copper, (oliven).
VERY DARK GREEN: Arseniate of copper.
GREENISH: Arseniate of lead.

As soon as a prospector has discovered a mine and ascertained the nature of the metal it contains, he must immediately inquire whether it is situated on government land, or on land sold by the federal government, or whether it is on a Mexican grant. In the first case, he may take immediate possession of the mine; in the second he must come to some arrangement with the owner of the land. The federal government sells the land, but not the mines it may contain; on the contrary a Mexican grant confers the right to both land and mines.

When such information has been obtained, the mine must be staked off, and a notice put up stating the date of the claiming of the mine, the extent and direction of the ground claimed, with the names of the parties for whom possession has been taken. A certain number of feet are allowed to each claimant, according to the district: in some districts 100 feet, in others 200 and even 300 feet. The prospector must conform to the established regulations.

If a discovery should take place in a district where no regulations have yet been established, it is advisable to stake off as small a number of feet as possible for each member of the company, say 100, so that when laws are made for that district the company's claim may not be reduced; in such case, a greater number of names

and a smaller number of feet is the safest plan to adopt.

Having put up the notice, the claimant must have the mine recorded, stating accurately its site, direction and extent, the names of the persons who compose the company, and the day on which the notice was posted up. He must obtain from the Recorder a duplicate of the record; ascertain the period at which the working of the mine is compulsory (this period varies with the locality); and lastly, inquire whether the same claim is not already recorded, and if not, obtain a certificate to that effect.

Having taken all these measures, he must then proceed to organize and incorporate the company.

In the report he will have to make to the Company, he must give every information he can procure respecting the locality, such as the distance at which lumber or fire wood may be obtained; how far it is situated from a stream or drinkable water; the condition of the roads by which the mine may be reached; in fine, he must state every circumstance that may facilitate or impede the working of the mine and the transportation of the ores; forward to the Company a certain quantity of ore taken, not only on the surface of the claim, but at as great a depth as possible; and lastly not to fail to give the company information on the neighbouring mines that are in operation; state their number, the condition of their works, their yield, and send specimens of their rock, if possible.

We will conclude this chapter with a few observations on the mines of Mexico, which will be of great benefit to the California miner.

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Two very distinct zones are observable in the metalliferous veins of a mine: in that which is within the decomposing influences of the atmospheric air, the metallic ores exist in the form of oxides, or in combination with carbonic acid, chlorine, bromine, etc., whereas the sulphur under the form of sulphuric acid appears to

have left the metals to combine with the earthy bases intermixed with metallic substances, to form sulphates of these bases. In this zone, the ores which almost always contain much oxide of iron, derive their name from their color, being called by the Mexican miners *colorados* or *red ores;* they are in general more easily reduced than the other kinds.

At the point where atmospheric influences cease, the metallic bases of the ores preserve their primitive state of combination with sulphur. It is there that we find pyrites, blende and sulphurets of silver, which are sometimes reduced to the metallic state, most frequently in streaks. When blende and galena prevail they are of a darker color, and are called by the Mexicans *negros* or *black* ores; they supply the seven eighths of all the silver derived from the Mexican mines.

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Some metalliferous beds are richest near the surface; such occur in Sonora and Chihuahua; but this is not generally the case, silver being found in greater abundance at a certain depth varying according to the locality.

When a certain limit has been reached the proportion of silver decreases, and this circumstance, together with the increased expense of extracting the ores and of draining, which, causing the working of the deepest mine in Mexico to be abandoned, was an obstacle to ascertaining whether one or several very rich zones existed in the same vein. Great differences in the proportion of silver have been observed in spaces where the width of the vein and the nature of the rock are the same; but it is known with certainty that in the Tasco mines, in passing from argilaceous schist to talcose schist situated below, the proportion of silver is considerably less.

The richness of the Mexican mines has constantly decreased between 750 and 900 feet, and even all the mines situated at the foot of the northern slope of the Zacatecas Mountains are rich only at a small depth from the surface.

The direction of the majority of the mines in Mexico is North and South, and obliquely, East and West; it may even be positively affirmed that those that have yielded the largest quantity of silver, are on a line running North-West and South-East. The dip is rather to the south than to the north, and the angle with the horizon is seldom less than 45 degrees; it is in consequence of this that the measurement of mineral grants in Mexico is calculated on angles of 45 to 90 degrees.

The width of the veins varies considerably.

Ordinary veins are only from six feet to a few inches wide; in the latter case they are called ribbons (cintas); their small dimensions are frequently compensated by extraordinary richness in silver.

The San Clemente and San Nicholas vein seldom reaches a width of six feet, but the intervals that separate the metallic portions of the ore, the selvages and walls are impregnated, to a considerable thickness, with the same metallic substances that abound in the vein, to such an extent even that their extraction is often as profitable as that of the vein itself. The rock is chloritic schist, in which some quartz banks occur several yards thick.

The vein of the *Veta Madre* of Guanajuato is sometimes 180 feet wide; it consists of quartz intermixed with gold and silver. It is undoubtedly the most remarkable argentiferous vein in any part of the world, as well for its dimensions and the regularity of its dip and composition, as for the magnificence of its works; this vein is seldom less than 40 feet wide; its thickness varies from 24 to 75 feet.

The *Veta Grande* is the next largest vein that is worked in Mexico. Its width at San Acasio reaches 130 feet, but generally it is not more than 30 to 36 feet.

In the *Veta Grande* and the *Veta Madre* the vein, is divided into 3 different bodies overlaying each other, the banks of quartz by which they are separated have a thickness of 9 to 12 feet.

In some mines the veins intersect each other so as to

form a kind of net work; this is observed to be the case in the Fresnillo mines.

A Discovery in California.

The docimastic value of silicates has been known for a long time. Debette says:

"Silica is often employed to determine the fusion of basic gangues in assays made at a high temperature. It is often replaced by clay which, containing a certain quantity of alumina, renders the gangues more fusible. That is better than to add a mixture of silica and alumina. In cases where the gangue is argillaceous or silicious, a clay containing much alumina is used."

The earthy silicates are the most convenient fluxes, and they are more fusible in proportion as they contain a greater number of bases. This is the reason why the silicate of lime does not become sufficiently fusible until a considerable quantity of oxyde of iron has been dissolved, so as to form a double silicate of lime and iron.

In the furnaces of the Lower Hartz, the copper ores are smelted with an argillaceous schist, which serves as a flux. This substance is ordinarily soft, but it becomes hard in its passage to certain silicious rocks. In this rock, apparently homogeneous, with an earthy texture, there are occasionally red or reddish crystals of macle, in obliterated square prisms, having the appearance of rhomboidal prisms. Sometimes this argillaceous schist has a hard green or greenish body, either compact or crystallized. Analysis shows that it contains 40 per cent. of silica, 34 of alumina, 60 of lime, 8 of protoxide of iron, and 1 of oxyde of manganese.

Certain varieties of this schist present a stratiform structure, with a shell-like transverse feature; others have thin and smooth plates like leaves of slate. All these varieties of silica are good fluxes, particulary for the metals, which require a high temperature to enter

into fusion; but the best are incontestably, as we have before said, those which have a larger number of bases.

But California, so fertile in minerals, stood in imperative need of a powerful flux to draw from its mineral resources all the profit which it had a right to expect from them. The county of Contra Costa has just supplied the want, and it has supplied it before the important ores of copper have yet taken the habit of exportation to the East or to Europe.

To this flux various improper names were given at first, such as cadmium, sulphuret of cadmium, silicate of cadmium, silicate of cadmium and vanadium, etc. It contains no cadmium, but is a silicate with many bases, including alumina, iron, magnesia, potash and manganese. It is found in Contra Costa county in various forms, such as an earth with crystals of macle, laminated masses that break up like slate, or in a hard rock, with a greenish black color.

The multitude of the bases of this silicate makes it one of the most potent fluxes, and by its aid, the different ores of copper, as well as of other metals, may be reduced with great economy of time, fuel and labor. The multiplicity of bases renders this flux as superior to the fluxes used in Europe, as the coal of Newcastle is superior to that of California.

It is said that the discoverer of this body of silicates intends to take out a patent, which will give him the exclusive right of using it as a flux. What would be said, if those persons who having discovered the tin mines of Temascal, in San Bernardino, had been foolish enough to apply for a patent to secure to them a monopoly of tin mines and of covering sheet-iron with tin? Would not their application be the same as that of him who has discovered the bed of silicates?

Mexican Mining Laws and Regulations.

A newly discovered mine belongs to any person who denounces it, provided a shaft of at least ten varas in depth be sunk on the vein, within sixty days after it is denounced.

A claim consists of two hundred varas square. Mines that have been abandoned, or those in which work has been suspended for a space of four consecutive months, may also be denounced.

The reducing and crushing works (*haciendas de beneficio*) are considered as having been abandoned, and may become the property of whomsoever denounces them, when they no longer serve for their original purpose; when the roofs have fallen in, and the machinery has been removed; but the owner has a delay of four months to resume operations if he wishes to preserve his property.

A miner, or the proprietor of metallurgical works cannot be expropriated by his creditors, who may take possession of the mine and work it for their own account, until the debt contracted by the owner is extinguished; but they are compelled by law to allow him sufficient means to maintain himself and family.

The working of Silver Mines in Mexico.

We shall now briefly describe the different circumstances attending the working of a Mexican mine,(1850).

A shepherd or a laboring man accidentally discovers near those *crestones* which rise above the surface, quartz containing metallic substances. He endeavors to procure some rock at a depth where it has not felt the action of the atmospheric air, builds a fire in which he roasts a few pieces of ore at a very high temperature, and if specks of silver are observed, the mine is denounc-

ed for the purpose of securing possession of it to the discoverer.

The law requires a shaft to be sunk in the vein of a depth of at least ten varas, within sixty days after the denouncement, at the expiration of which, if the mine has been ascertained to be a new one, or to have ceased to be the property of a former denouncer, a grant is made of two hundred varas square. The grantee then procures partners to develope the mine, should he lack capital for that purpose. The value of the mine is divided into twenty-four shares, called *barras*, the half of which is given over to the capitalists, named *aviadores*. The regular developement of the mine then commences.

When a depth has been reached where silver is generally the most abundant, and the quantity of water and expenses of extraction are not yet too considerable, the yield is very remunerative; at this stage of the development, reducing works are erected (*haciendas de beneficio*), frequently on a large scale, not always based on the future probable yield of the veins.

At the same time underground work is carried on to facilitate mining operations, as also the extraction of the ore, and the draining of the mine.

When mines in the bonanza condition are in the hands of one individual as in the case of Counts de Valenciana and Reglas, and the Marquis de Rayas, these works are remarkable not only for their magnificence and extent but for their utility in less prosperous times, when without them the ores becoming poorer could not be extracted through the older communications.

In most cases at the present day, the twenty four barras, which constitute the shares of a mine, are divided into small fractions, and represent numerous conflicting interests which seem to combine but for one purpose, that of realizing from the undertaking as much as possible, disregardful of the evil consequences which may affect the future prosperity of the mine. Their motto appears to be: "sufficient unto the day is the *profit* thereof." The consequence of this view of mining

operations is that no regular and methodical course is pursued, the richest ore only being extracted at several places at the same time, or where it is the most easily obtained, masses of poorer ore being left behind, the working of which is resumed when the *bonanza* ceases.

It is difficult to understand why a small amount of these enormous profits is not devoted to researches which are undertaken only when the expenses exceed the profits, and the prospects of a profitable investment are doubtful.

When the zone of the greatest yield has been worked through, if the depth is such as to render the cost of extraction too considerable, the *bonanza* ceases.

The poorest ore left in the upper parts of the mine is then worked, and as the greatest expense is the draining, the water is allowed to fill the lower works.

For some time the reserve of ore of medium yield is sufficient to cover expenses; but beyond a certain point, day or contract work for a certain weight of ore extracted is no longer profitable; and in order to guard against the chances of loss, the miners are allowed an interest in the profits, say one sixth, one quarter, one third, and even one half of what they extract. The owner furnishes tools, light and powder, the draining and hoisting being also at his expense. This is called *partido;* the miners who are then called *buscones* prefer it to day or task work, and as it is voluntary labor, they take it *easy*, and find a certain charm in being indebted to chance for their salary, which will frequently, in one week, be enormous, after having worked for a month or more without earning scarcely sufficient for their maintenance.

Gradually the resources are exhausted, and the number of men only required by law are kept at work, in order to retain possession of the mine, and new *aviadores* are found who supply the funds necessary for the expense of draining and continuing the work in the lower part of the mine, running prospecting drifts at points where rich ore was expected to be found, but which had been neglected when the mine was free of water.

A TABLE OF STAMP DUTIES

ON

DEMANDE AND TIME NOTES,

INLAND BILLS OF EXCHANGE, ETC.

AMOUNT.	Demand, or 30 Days.	60 Days.	90 Days.	4 Months.	6 Months.	Over 6 Months.
$20 to $200	$0 01	$0 02	$0 03	$0 04	$0 06	$0 10
200 to 400	0 02	0 04	0 06	0 08	0 12	0 20
400 to 600	0 03	0 06	0 09	0 12	0 18	0 30
600 to 800	0 04	0 08	0 12	0 16	0 24	0 40
800 to 1,000	0 05	0 10	0 15	0 20	0 30	0 50
1,000 to 1,200	0 06	0 12	0 18	0 24	0 36	0 60
1,200 to 1,400	0 07	0 14	0 21	0 28	0 42	0 70
1,400 to 1,600	0 08	0 16	0 24	0 32	0 48	0 80
1,600 to 1,800	0 09	0 18	0 27	0 36	0 54	0 90
1,800 to 2,000	0 10	0 20	0 30	0 40	0 60	1 00
2,000 to 2,200	0 11	0 22	0 33	0 44	0 66	1 10
2,200 to 2,400	0 12	0 24	0 36	0 48	0 72	1 20
2,400 to 2,600	0 13	0 26	0 39	0 52	0 78	1 30
2,600 to 2,800	0 14	0 28	0 42	0 56	0 84	1 40
2,800 to 3,000	0 15	0 30	0 45	0 60	0 90	1 50
3,000 to 3,200	0 16	0 32	0 48	0 64	0 96	1 60
3,200 to 3,400	0 17	0 34	0 51	0 68	1 02	1 70
3,400 to 3,600	0 18	0 36	0 54	0 72	1 08	1 80
3,600 to 3,800	0 19	0 38	0 57	0 76	1 14	1 90
3,800 to 4,000	0 20	0 40	0 60	0 80	1 20	2 00
4,000 to 4,200	0 21	0 42	0 63	0 84	1 26	2 10
4,200 to 4,400	0 22	0 44	0 66	0 88	1 32	2 20
4,400 to 4,600	0 23	0 46	0 69	0 92	1 38	2 30
4,600 to 4,800	0 24	0 48	0 72	0 96	1 44	2 40
4,800 to 5,000	0 25	0 50	0 75	1 00	1 50	2 50
Over $5,000 for each 200	0 01	0 02	0 03	0 04	0 06	0 10

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Mexican Weights.

1 quintal = 4 arrobas = 100 pounds = 1,600 ounces = 200 marcs.
1 arroba = 25 pounds = 400 ounces = 50 marcs.
1 pound = 16 ounces = 2 marcs.
1 ounce = ½ marc.

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SUBSTANCES : — Milk, Tea, Oranges, Lemons, Strawberries, Raspberries, Blackberries, Cherries, Pineapples, and other fruits: Rum Jamaica, Cognac, Arac, Kirschwasser, Gin, Whiskey, and Wine. From these substances, carefully and proportionally combined, I derive those several beverages that I have denominated Punches.

PROPERTIES : — Tonic, nutritive, diaphoretic, diuretic, antibilious, totally free from those deleterious effects produced upon the human system by the use of raw liquors. A few of the many results such use occasions, may be here mentioned, such as "Toddy Blossoms," pimples, blotches on the face, dyspepsia, offensive breath, vitiated taste, morbid appetite, gout, physical and mental prostration. The use of Squarza's Punches will restore to their normal state those organs deranged by the use of raw liquors. — They will impart strength and activity to the intellectual faculties, materially aid the digestive organs in the performances of their regular functions, and infuse into and throughout the whole system, instead of the morbidity, dullness and torpor produced by indulgence in raw liquors, a feeling of gaiety and pleasurable excitement, never followed by cramp in the stomach, dizziness or headache, even should the temptations of the table induce an infraction of the rules of temperance. Miners, mariners, and travelers by land and sea, will endorse Squarza's Punches as incomparable. They combine with their exquisite flavor as beverages the properties which produce a speedy and efficient cure of sea-sickness, and act as a valuable preventative of fever and dysentery. Persons of sedentary habits or pursuits, or engaged in exhausting mental occupations, will find no equal to these punches in the whole range of beverages. They gradually warm the whole system to a comfortable condition, infuse a new spirit into its jaded faculties, without imparting the heating excitements followed by prostration which are produced by the use of raw liquors Families, parties, excursionists, and others, will acknowledge that Squarza's Punches are the most grateful, the most luxurious, convenient and economical of libations. V. SQUARZA.

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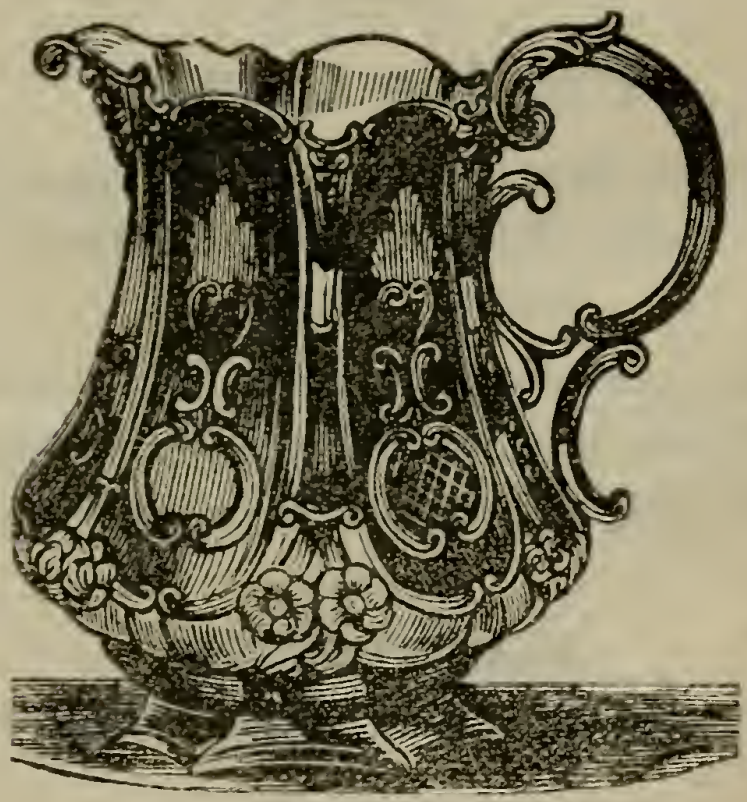
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